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[45] Date of Patent: * May 5, 1992

[54] AUTO FREEZE FRAME DISPLAY FOR INTRUSION MONITORING SYSTEM

[75] Inventors: Charles H. Erickson, Woodridge; Peter A. Erio, Morris; James E. Kase, Tinley Park, all of Ill.

[73] Assignee: Commonwealth Edison Company, Chicago, Ill.

[*] Notice: The portion of the term of this patent subsequent to Apr. 28, 2009 has been disclaimed.

[21] Appl. No.: 765,213

[22] Filed: Sep. 25, 1991

Related U.S. Application Data

[62] Division of Ser. No. 548,847, Jul. 6, 1990.

[51] Int. Cl.[5] H04N 7/18

[52] U.S. Cl. 358/108; 358/181

[58] Field of Search 358/108, 105, 210, 181, 358/903

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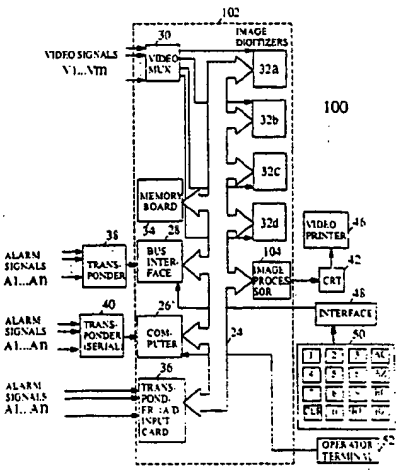
Primary Examiner—Victor R. Kostak

Attorney, Agent, or Firm—S. T. Naumann; William A. Webb

[57] ABSTRACT

A video monitoring system responds to an intrusion alarm by automatically presenting still video images of the zone of the alarm at or about the time of the alarm. The operator can control magnification and contrast to enhance the displayed image. In one system the displayed images are images taken at times both before and after the alarm was received by the monitoring system.

16 Claims, 18 Drawing Sheets



10/02/2003, EAST Version: 1.04.0000

FIG 1 (PRIOR ART)

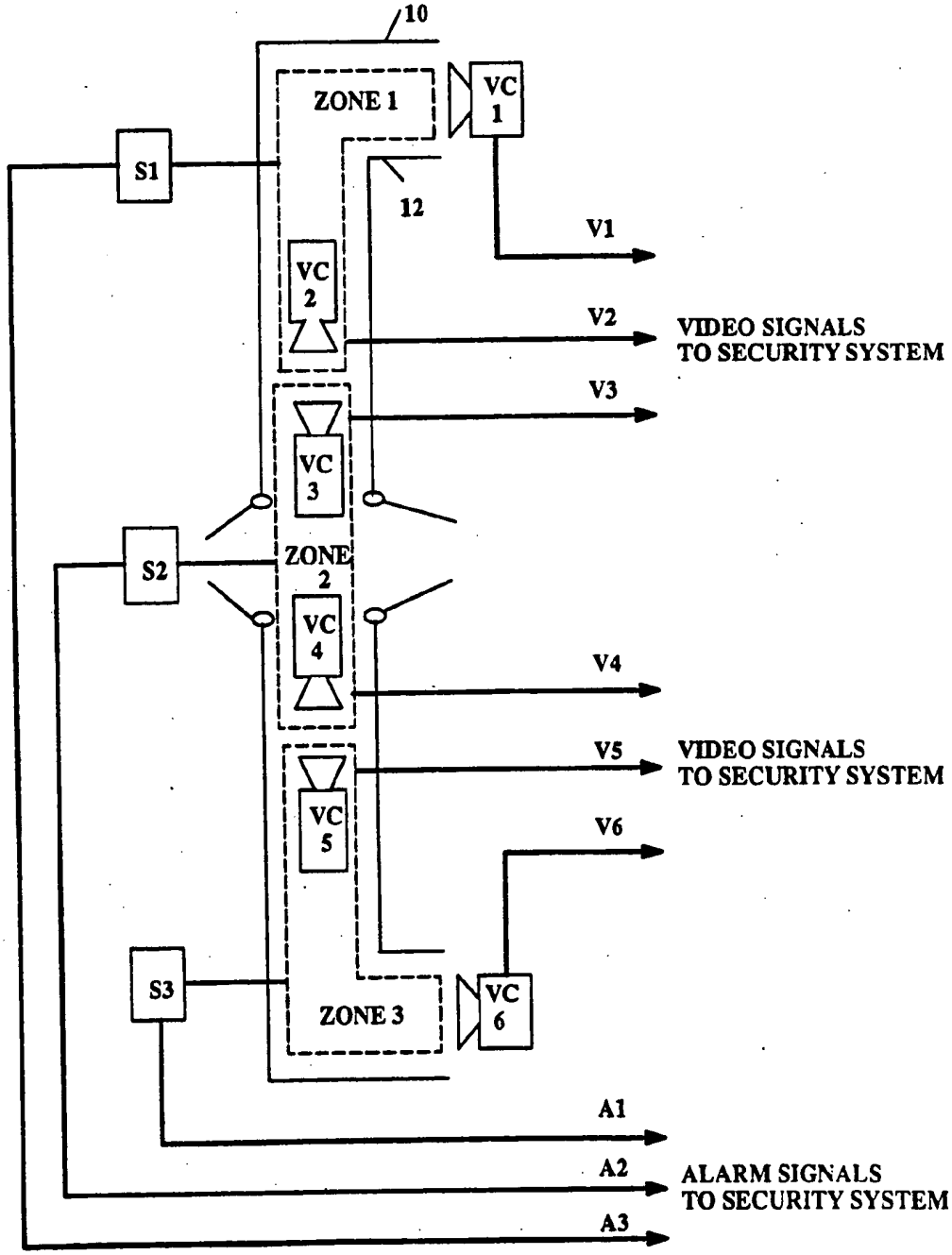


FIG 2

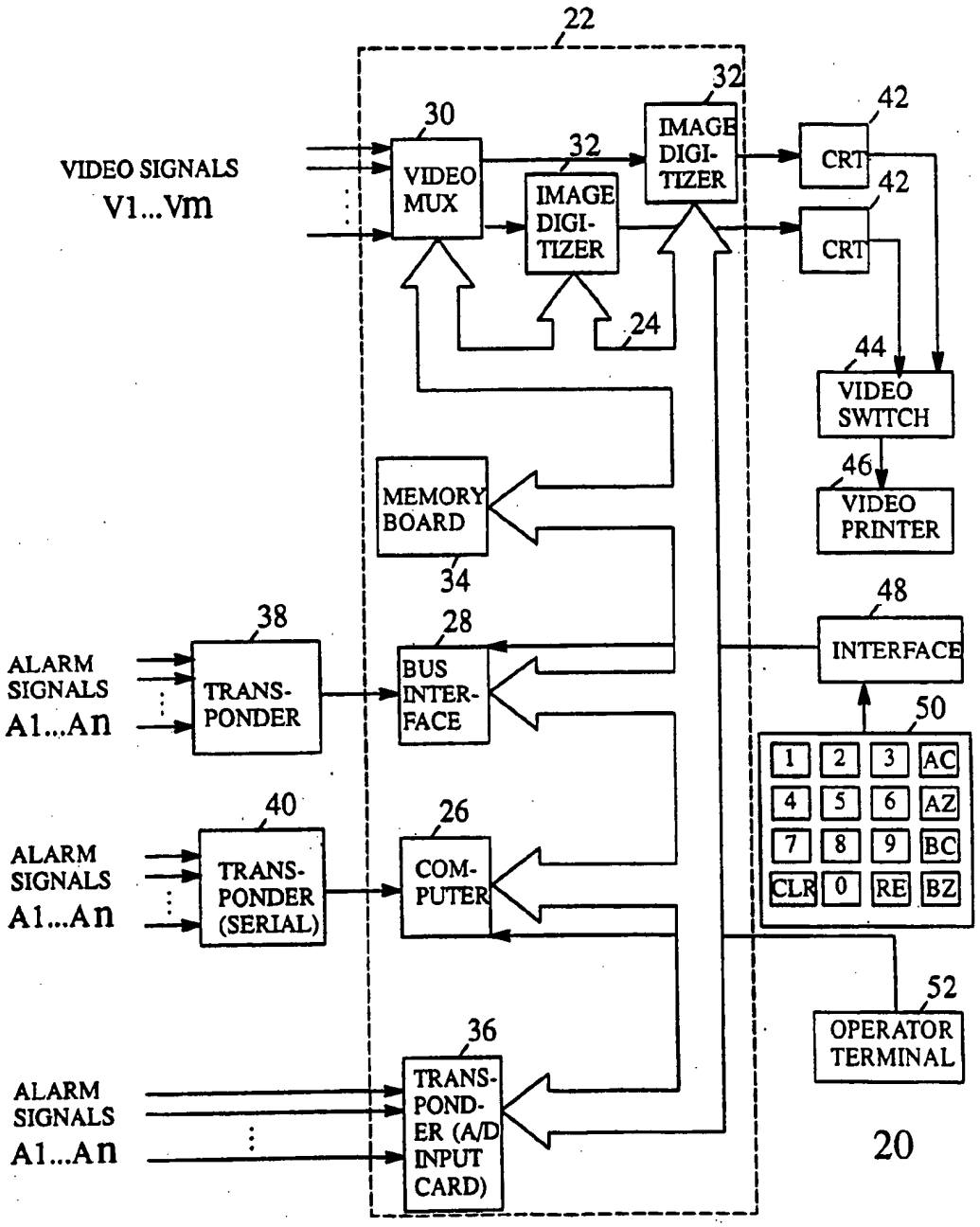

22
VIDEO SIGNALS
V1...Vm
30
VIDEO MUX
32
IMAGE DIGI-TIZER
32
IMAGE DIGI-TIZER
42
CRT
42
CRT
24
44
VIDEO SWITCH
46
VIDEO PRINTER
MEMORY BOARD
34
48
INTERFACE
38
ALARM SIGNALS
A1...An
TRANS-PONDER
28
BUS INTER-FACE
50
1 2 3 AC
4 5 6 AZ
7 8 9 BC
CLR 0 RE BZ
40
ALARM SIGNALS
A1...An
TRANS-PONDER (SERIAL)
26
COM-PUTER
52
OPERATOR TERMINAL
36
ALARM SIGNALS
A1...An
TRANS-POND-ER (A/D INPUT CARD)
20

FIG 3

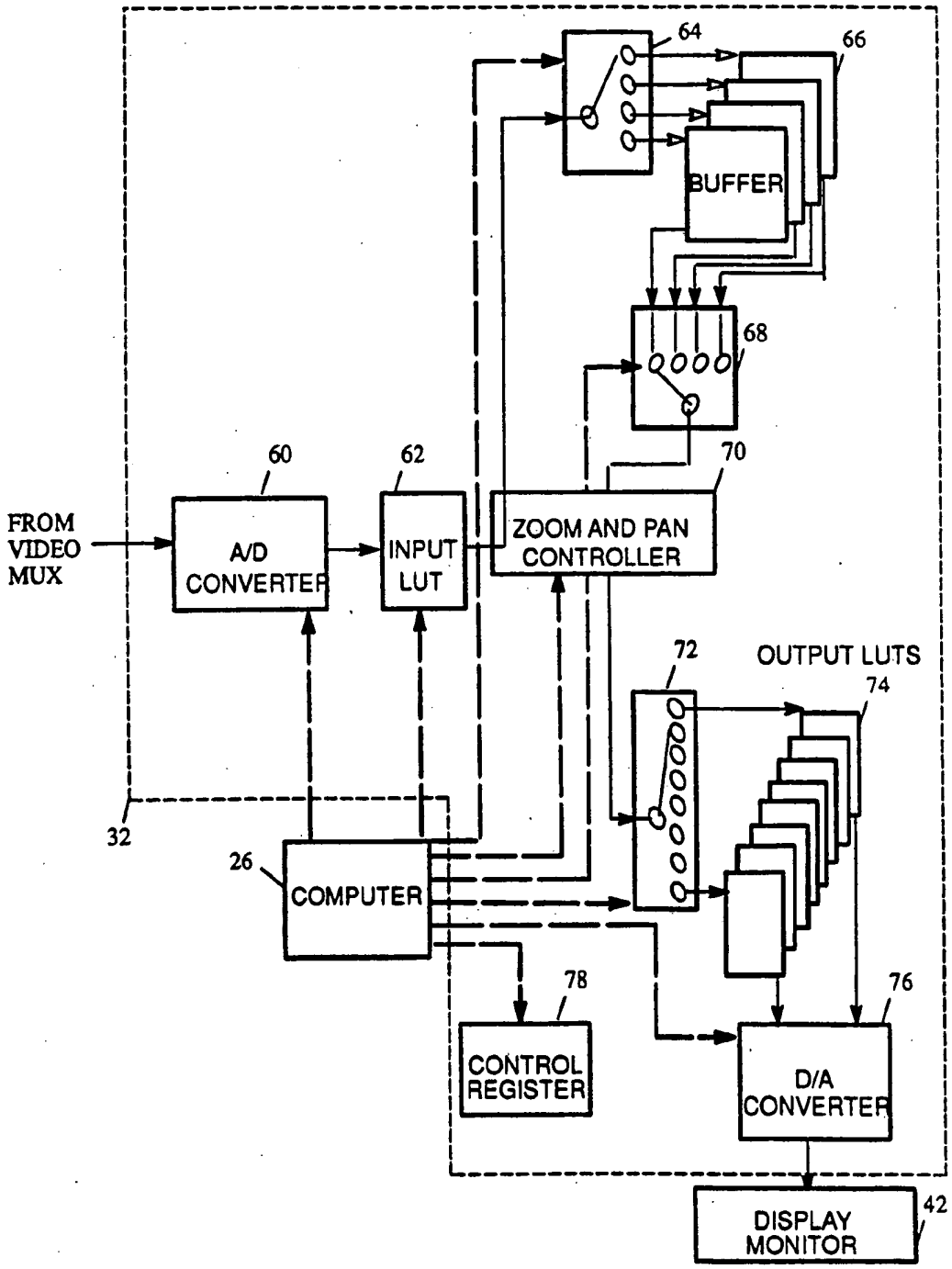

64
66
BUFFER
68
60
62
70
FROM VIDEO MUX
A/D CONVERTER
INPUT LUT
ZOOM AND PAN CONTROLLER
72
OUTPUT LUTS
74
32
26
COMPUTER
78
76
CONTROL REGISTER
D/A CONVERTER
DISPLAY MONITOR
42

FIG 4

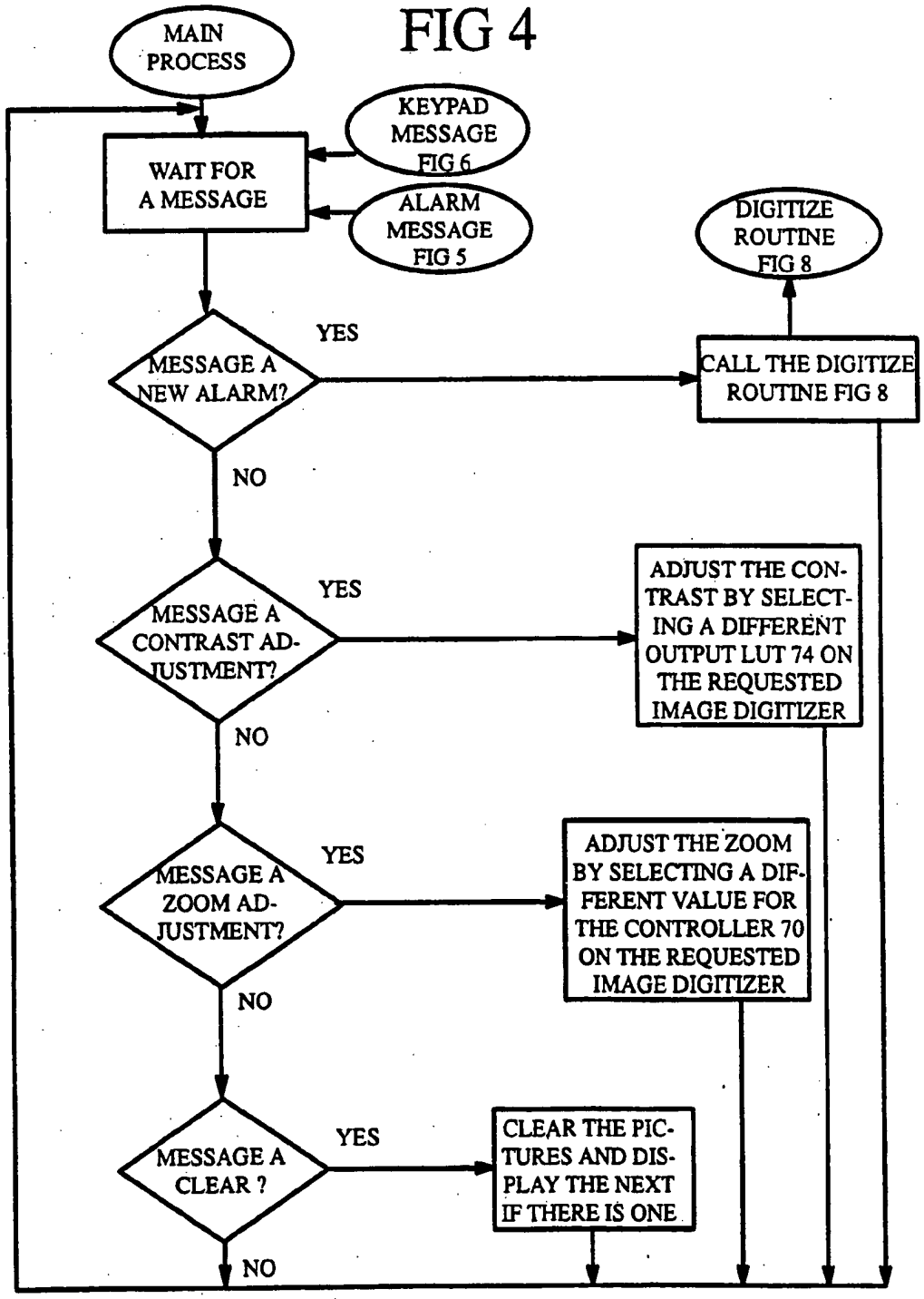

MAIN PROCESS
KEYPAD MESSAGE FIG 6
WAIT FOR A MESSAGE
ALARM MESSAGE FIG 5
DIGITIZE ROUTINE FIG 8
YES
MESSAGE A NEW ALARM?
CALL THE DIGITIZE ROUTINE FIG 8
NO
YES
MESSAGE A CONTRAST ADJUSTMENT?
ADJUST THE CONTRAST BY SELECTING A DIFFERENT OUTPUT LUT 74 ON THE REQUESTED IMAGE DIGITIZER
NO
YES
MESSAGE A ZOOM ADJUSTMENT?
ADJUST THE ZOOM BY SELECTING A DIFFERENT VALUE FOR THE CONTROLLER 70 ON THE REQUESTED IMAGE DIGITIZER
NO
YES
MESSAGE A CLEAR ?
CLEAR THE PICTURES AND DISPLAY THE NEXT IF THERE IS ONE
NO

FIG 5

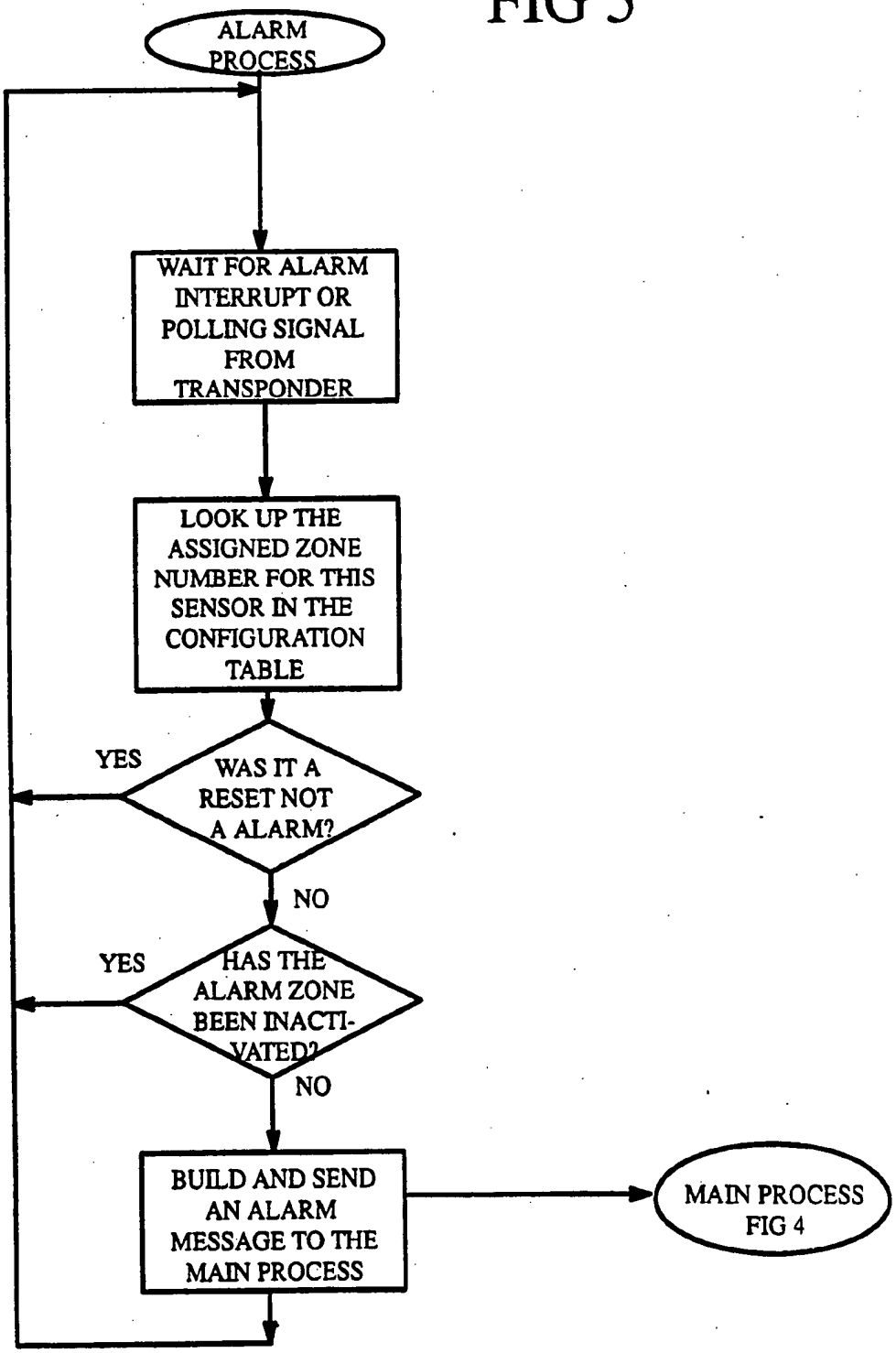

ALARM PROCESS
WAIT FOR ALARM INTERRUPT OR POLLING SIGNAL FROM TRANSPONDER
LOOK UP THE ASSIGNED ZONE NUMBER FOR THIS SENSOR IN THE CONFIGURATION TABLE
WAS IT A RESET NOT A ALARM?
YES
NO
HAS THE ALARM ZONE BEEN INACTI-VATED?
YES
NO
BUILD AND SEND AN ALARM MESSAGE TO THE MAIN PROCESS
MAIN PROCESS FIG 4

FIG 6

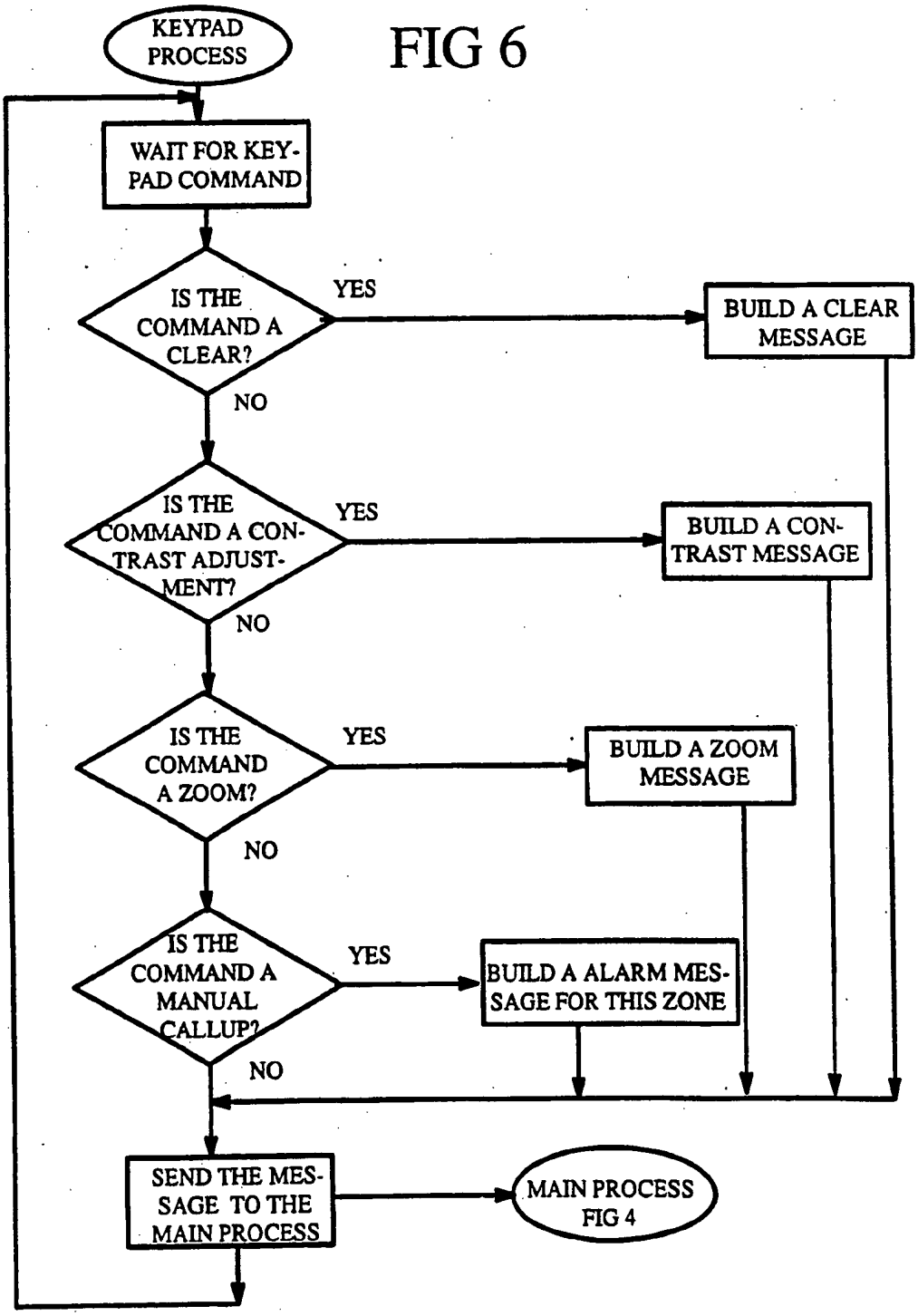

KEYPAD PROCESS
WAIT FOR KEY-PAD COMMAND
IS THE COMMAND A CLEAR?
YES
BUILD A CLEAR MESSAGE
NO
IS THE COMMAND A CON-TRAST ADJUST-MENT?
YES
BUILD A CON-TRAST MESSAGE
NO
IS THE COMMAND A ZOOM?
YES
BUILD A ZOOM MESSAGE
NO
IS THE COMMAND A MANUAL CALLUP?
YES
BUILD A ALARM MES-SAGE FOR THIS ZONE
NO
SEND THE MES-SAGE TO THE MAIN PROCESS
MAIN PROCESS FIG 4

FIG 7

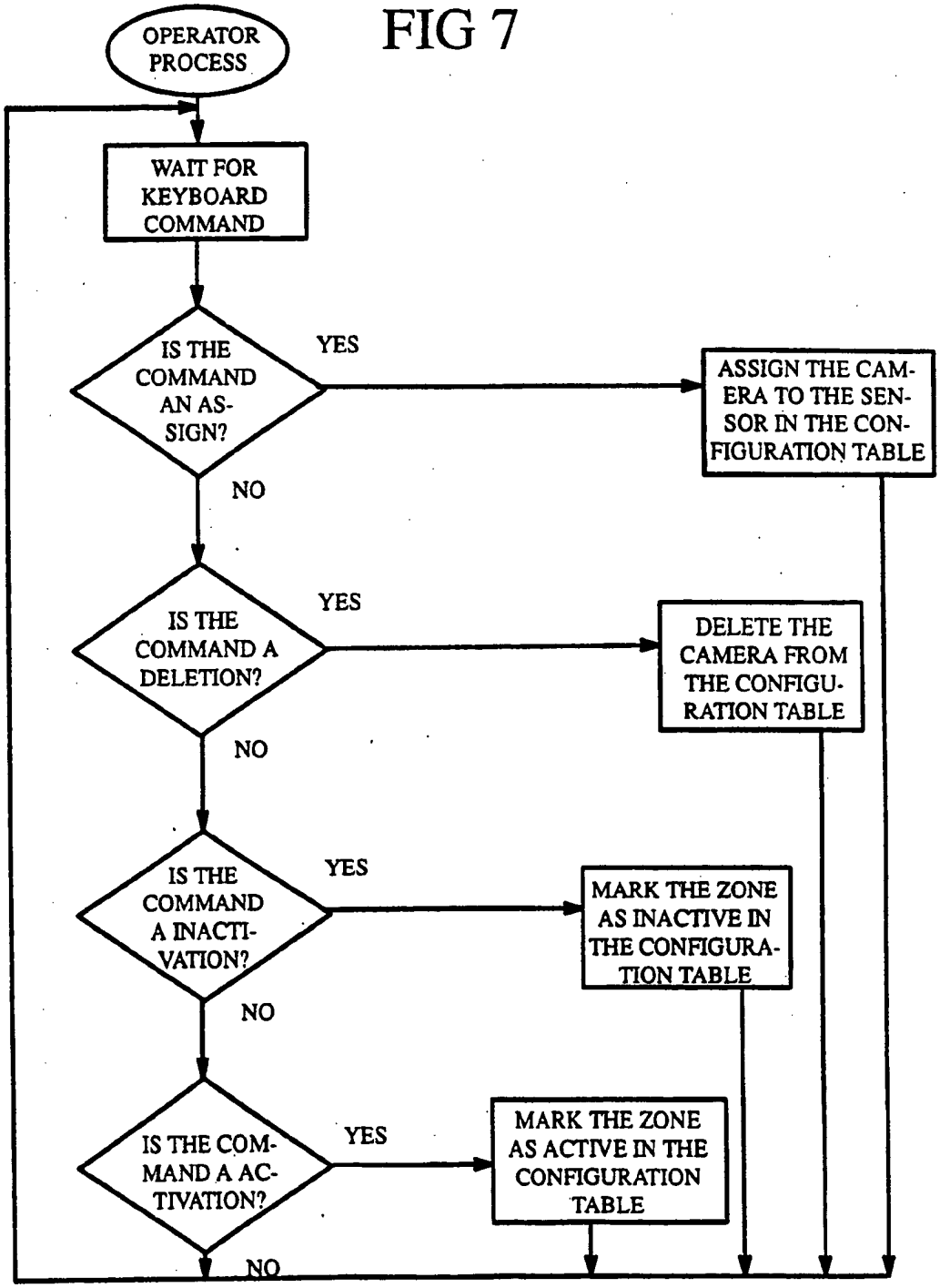

OPERATOR PROCESS
WAIT FOR KEYBOARD COMMAND
IS THE COMMAND AN ASSIGN?
YES
ASSIGN THE CAMERA TO THE SENSOR IN THE CONFIGURATION TABLE
NO
IS THE COMMAND A DELETION?
YES
DELETE THE CAMERA FROM THE CONFIGURATION TABLE
NO
IS THE COMMAND A INACTIVATION?
YES
MARK THE ZONE AS INACTIVE IN THE CONFIGURATION TABLE
NO
IS THE COMMAND A ACTIVATION?
YES
MARK THE ZONE AS ACTIVE IN THE CONFIGURATION TABLE
NO

FIG 8

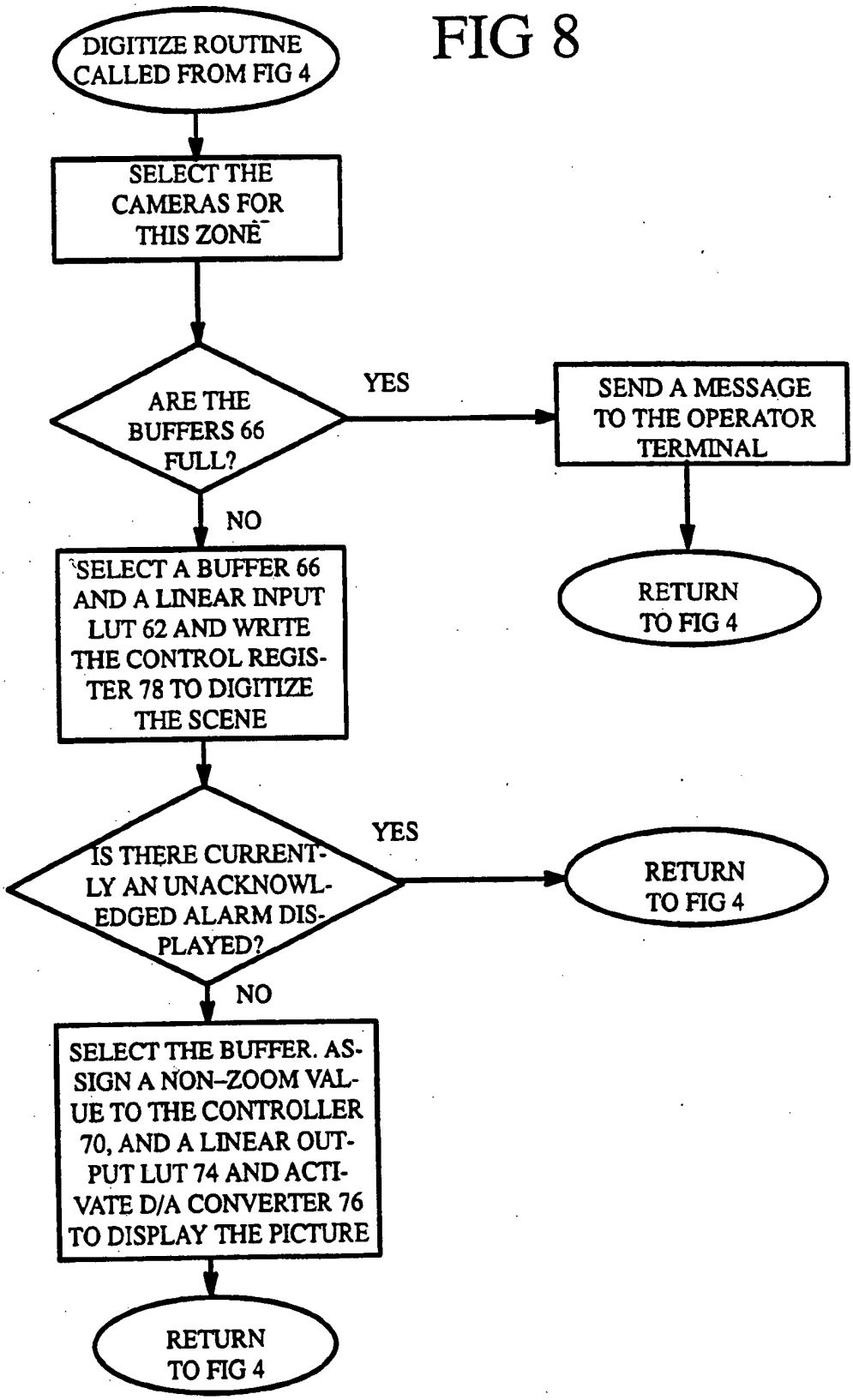

DIGITIZE ROUTINE CALLED FROM FIG 4
SELECT THE CAMERAS FOR THIS ZONE
ARE THE BUFFERS 66 FULL?
YES
SEND A MESSAGE TO THE OPERATOR TERMINAL
RETURN TO FIG 4
NO
SELECT A BUFFER 66 AND A LINEAR INPUT LUT 62 AND WRITE THE CONTROL REGISTER 78 TO DIGITIZE THE SCENE
IS THERE CURRENTLY AN UNACKNOWLEDGED ALARM DISPLAYED?
YES
RETURN TO FIG 4
NO
SELECT THE BUFFER. ASSIGN A NON-ZOOM VALUE TO THE CONTROLLER 70, AND A LINEAR OUTPUT LUT 74 AND ACTIVATE D/A CONVERTER 76 TO DISPLAY THE PICTURE
RETURN TO FIG 4

FIG 9

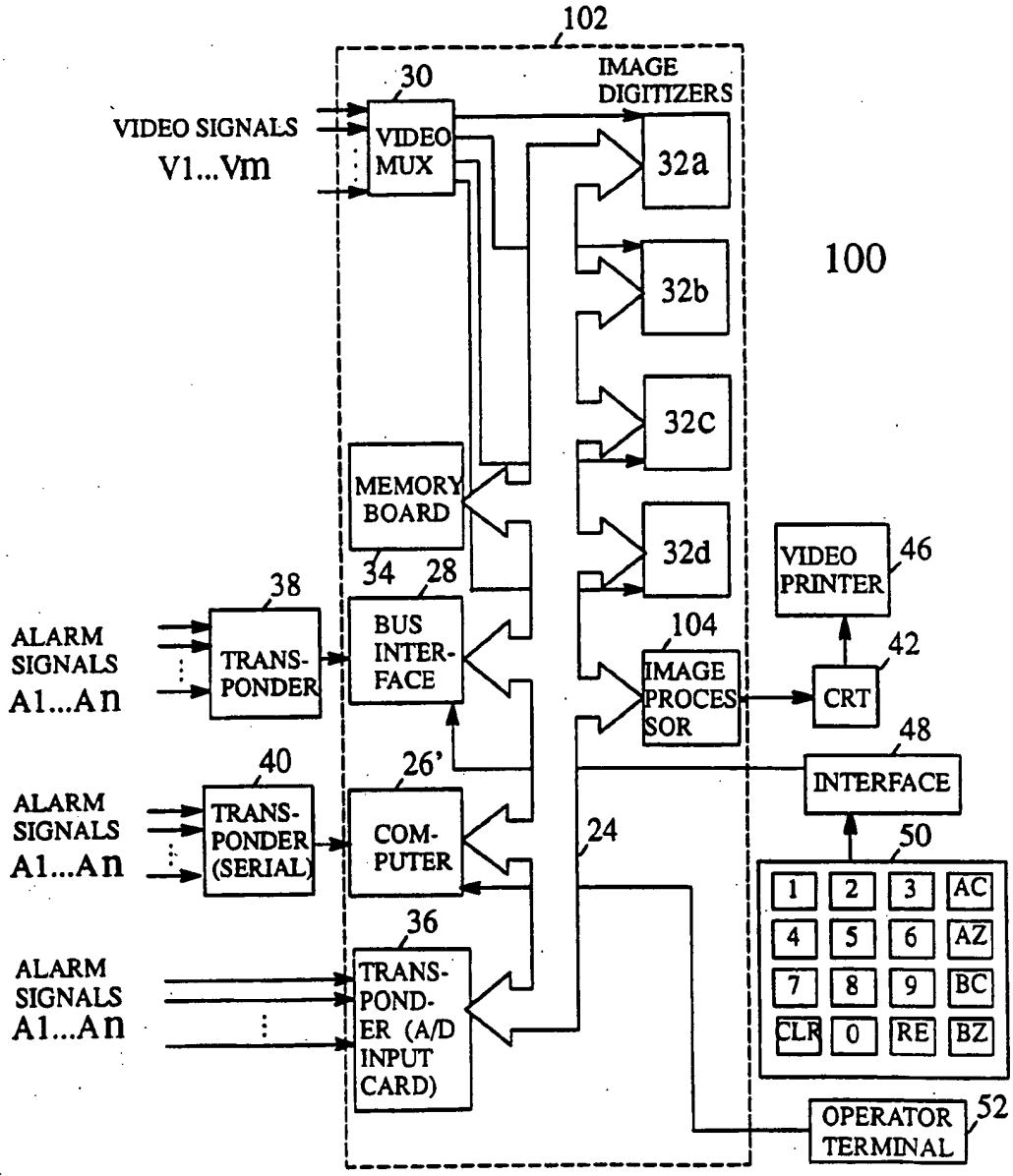

102
IMAGE DIGITIZERS
30
VIDEO SIGNALS
V1...Vm
VIDEO MUX
32a
32b
32c
32d
100
MEMORY BOARD
34
28
38
ALARM SIGNALS
A1...An
TRANS-PONDER
BUS INTER-FACE
104
IMAGE PROCES SOR
VIDEO PRINTER
46
42
CRT
48
INTERFACE
40
26'
ALARM SIGNALS
A1...An
TRANS-PONDER (SERIAL)
COM-PUTER
24
50
1 2 3 AC
4 5 6 AZ
7 8 9 BC
CLR 0 RE BZ
36
ALARM SIGNALS
A1...An
TRANS-POND-ER (A/D INPUT CARD)
OPERATOR TERMINAL
52

FIG 10

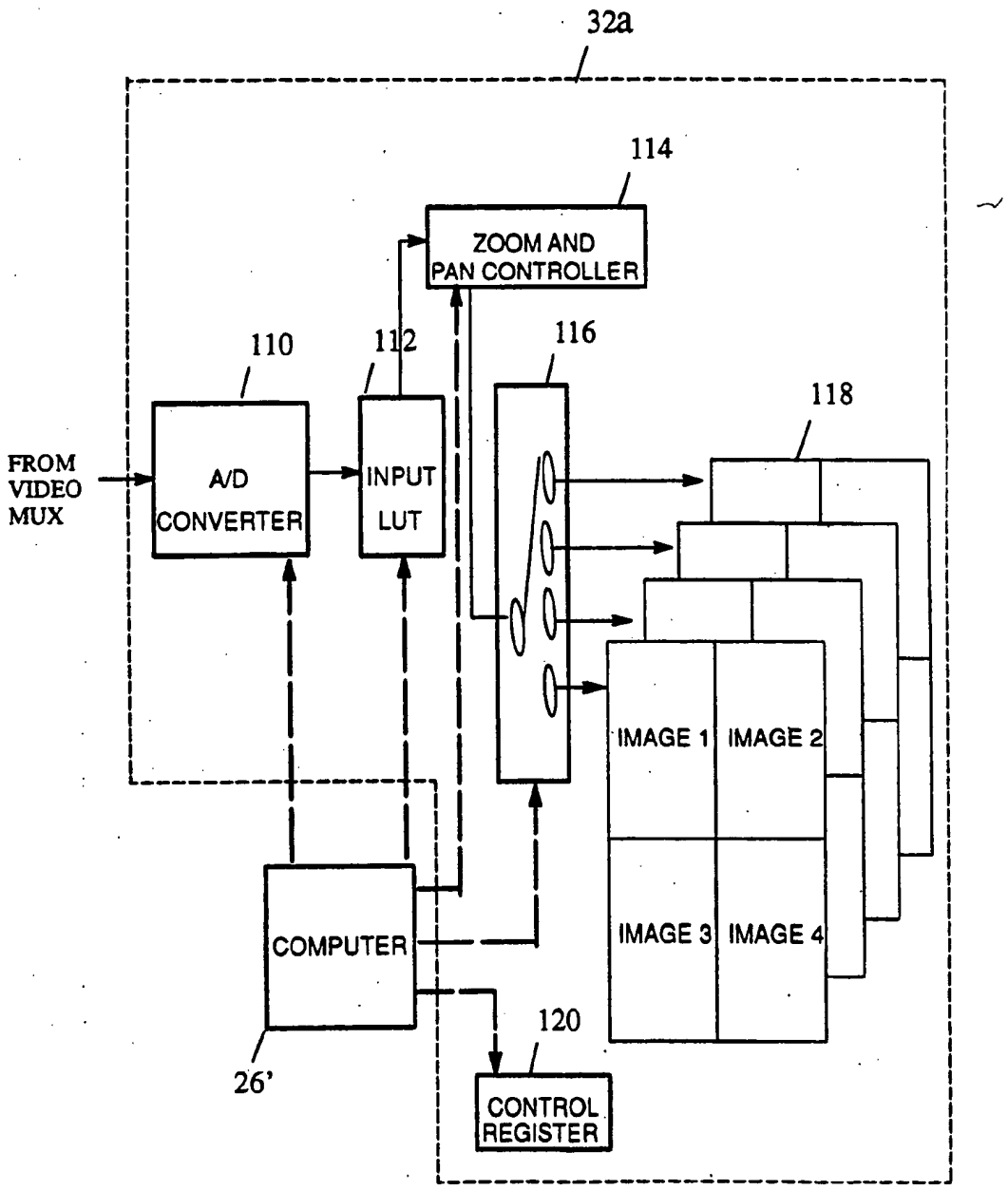

32a
114
ZOOM AND PAN CONTROLLER
110
112
116
118
FROM VIDEO MUX
A/D CONVERTER
INPUT LUT
IMAGE 1
IMAGE 2
IMAGE 3
IMAGE 4
COMPUTER
120
CONTROL REGISTER
26'

FIG 11

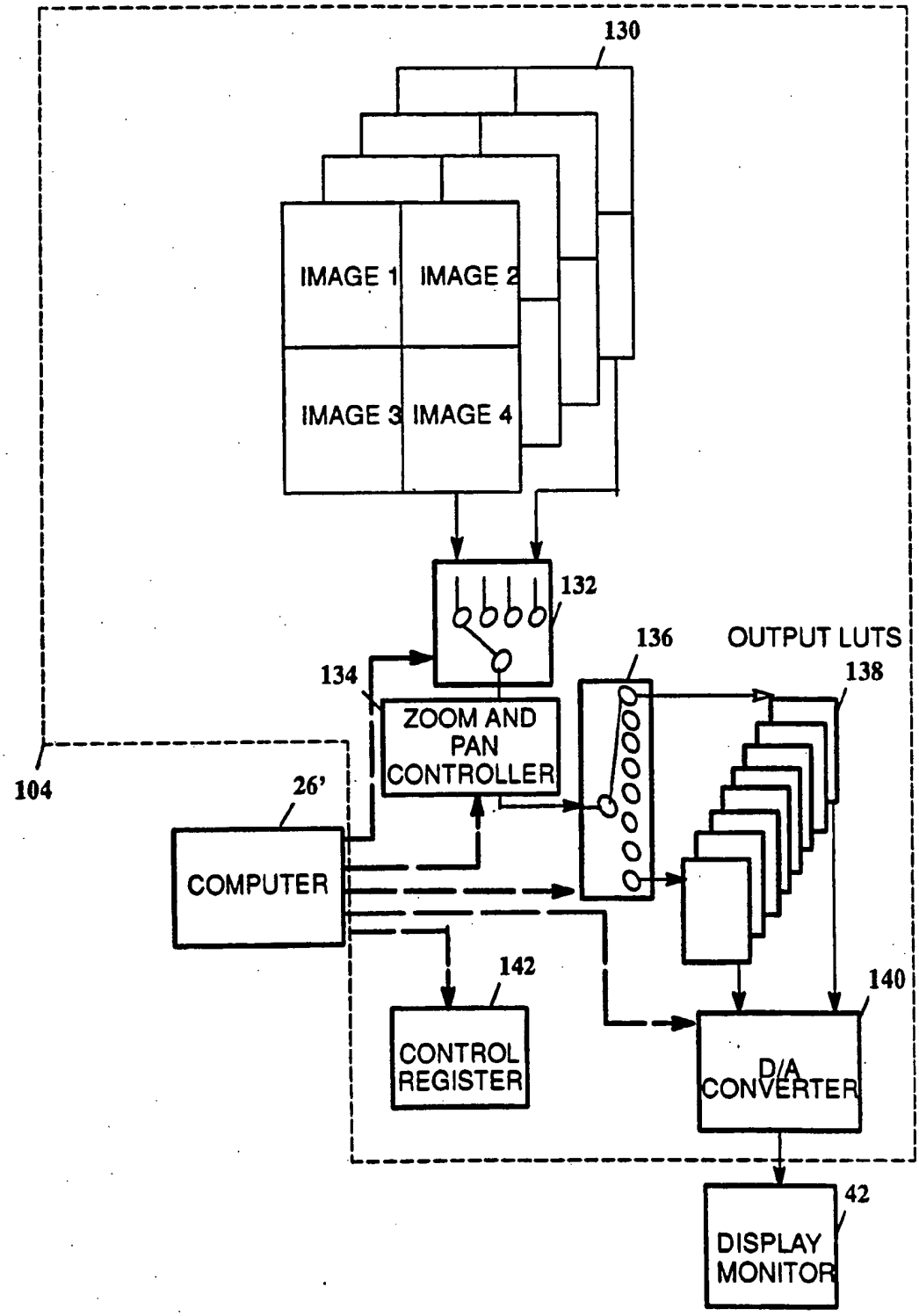

130
IMAGE 1
IMAGE 2
IMAGE 3
IMAGE 4
132
136
OUTPUT LUTS
138
134
ZOOM AND PAN CONTROLLER
104
26'
COMPUTER
142
CONTROL REGISTER
140
D/A CONVERTER
42
DISPLAY MONITOR

FIG 12

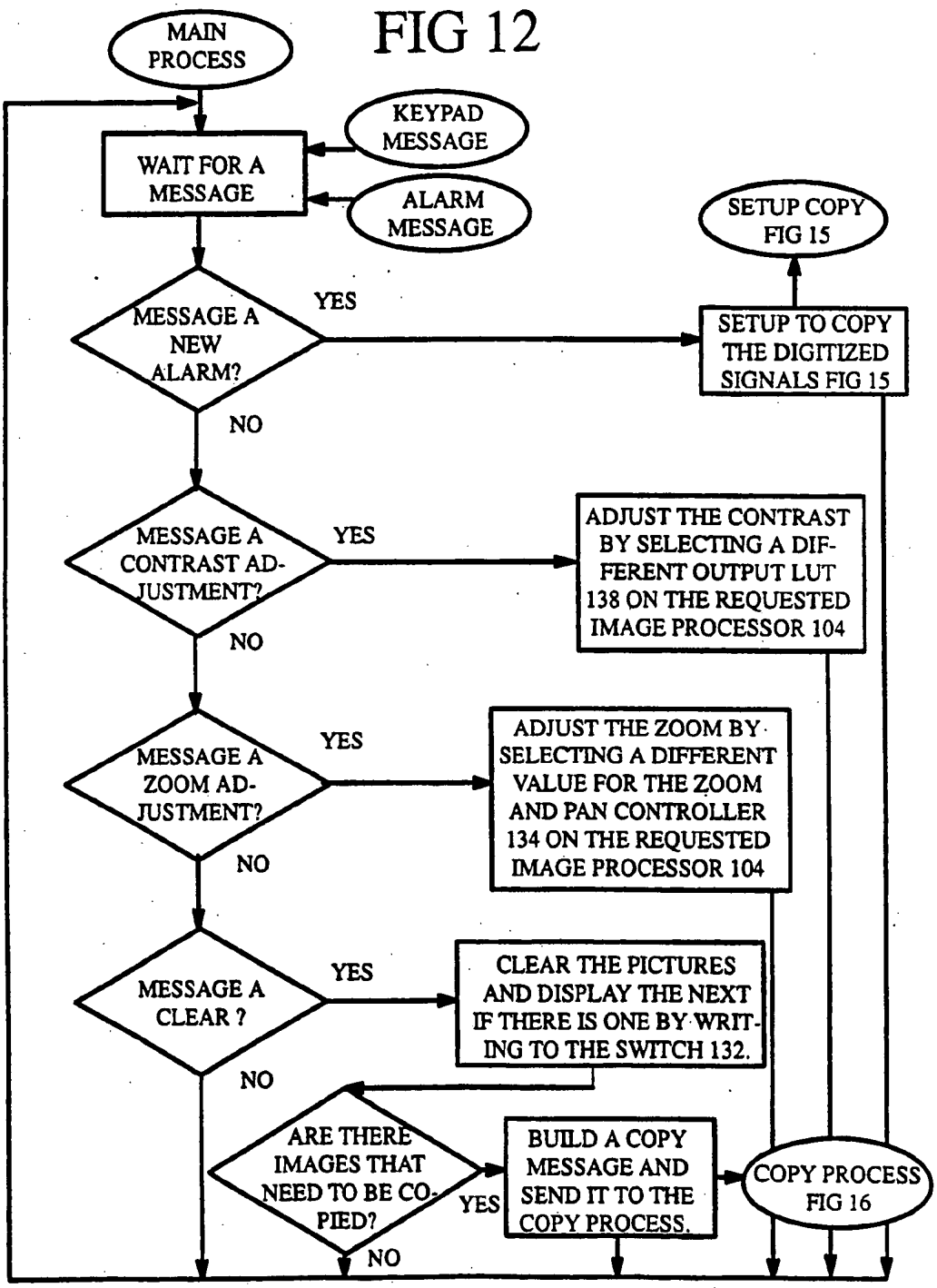

MAIN PROCESS
KEYPAD MESSAGE
WAIT FOR A MESSAGE
ALARM MESSAGE
SETUP COPY FIG 15
MESSAGE A NEW ALARM?
YES
SETUP TO COPY THE DIGITIZED SIGNALS FIG 15
NO
MESSAGE A CONTRAST ADJUSTMENT?
YES
ADJUST THE CONTRAST BY SELECTING A DIFFERENT OUTPUT LUT 138 ON THE REQUESTED IMAGE PROCESSOR 104
NO
MESSAGE A ZOOM ADJUSTMENT?
YES
ADJUST THE ZOOM BY SELECTING A DIFFERENT VALUE FOR THE ZOOM AND PAN CONTROLLER 134 ON THE REQUESTED IMAGE PROCESSOR 104
NO
MESSAGE A CLEAR ?
YES
CLEAR THE PICTURES AND DISPLAY THE NEXT IF THERE IS ONE BY WRITING TO THE SWITCH 132.
NO
ARE THERE IMAGES THAT NEED TO BE COPIED?
YES
BUILD A COPY MESSAGE AND SEND IT TO THE COPY PROCESS.
COPY PROCESS FIG 16
NO

FIG 13

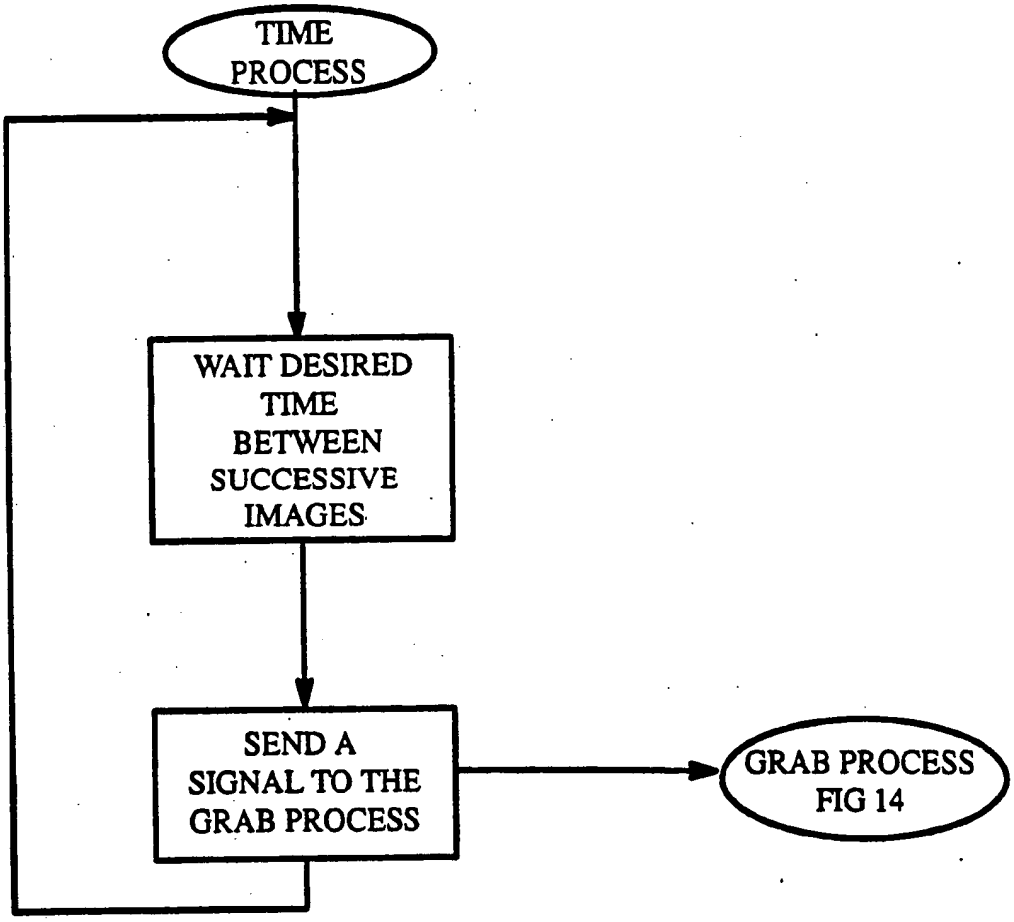

TIME PROCESS
WAIT DESIRED TIME BETWEEN SUCCESSIVE IMAGES
SEND A SIGNAL TO THE GRAB PROCESS
GRAB PROCESS FIG 14

FIG 14

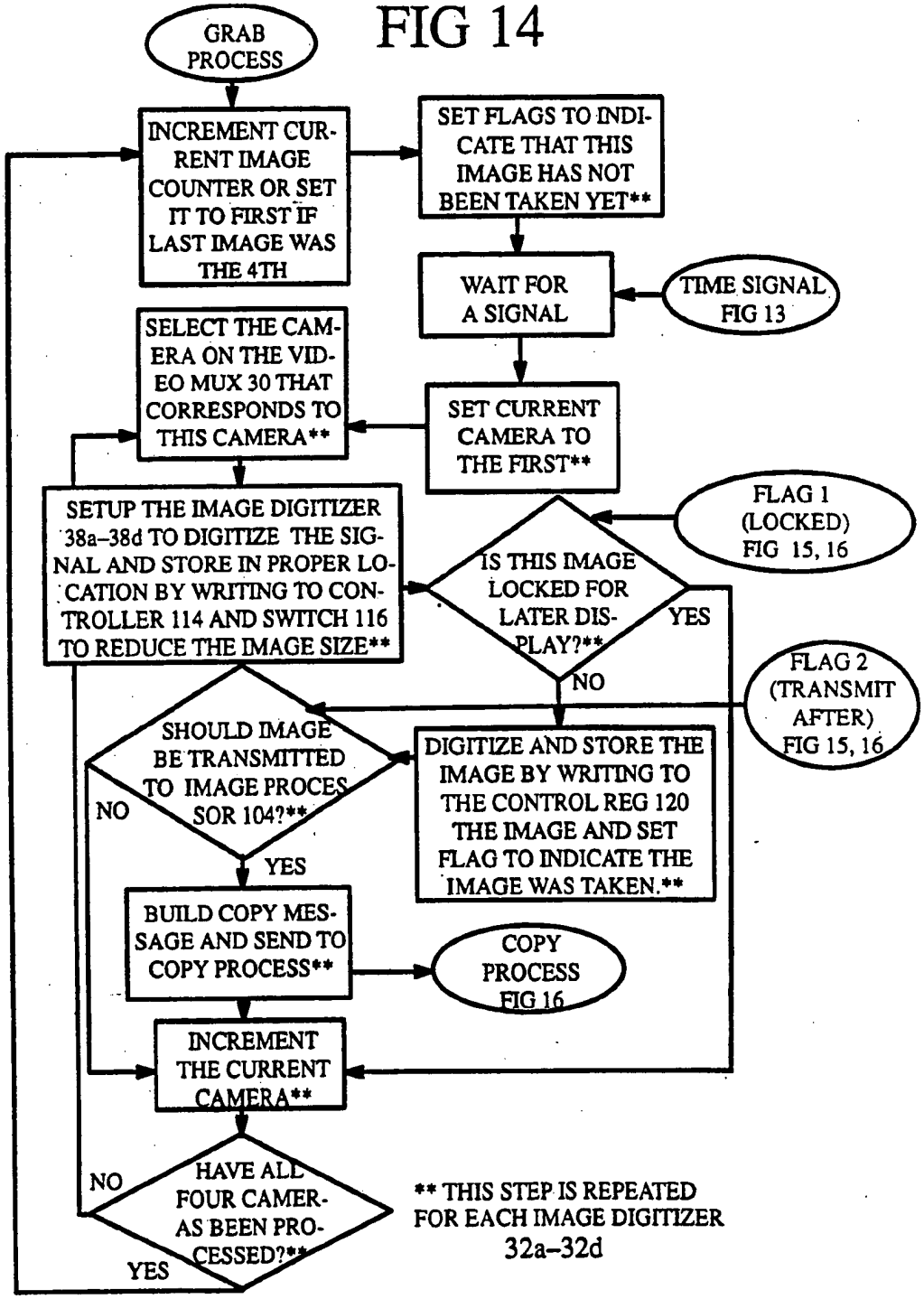

GRAB PROCESS
INCREMENT CURRENT IMAGE COUNTER OR SET IT TO FIRST IF LAST IMAGE WAS THE 4TH
SET FLAGS TO INDICATE THAT THIS IMAGE HAS NOT BEEN TAKEN YET**
WAIT FOR A SIGNAL
TIME SIGNAL FIG 13
SELECT THE CAMERA ON THE VIDEO MUX 30 THAT CORRESPONDS TO THIS CAMERA**
SET CURRENT CAMERA TO THE FIRST**
SETUP THE IMAGE DIGITIZER 38a–38d TO DIGITIZE THE SIGNAL AND STORE IN PROPER LOCATION BY WRITING TO CONTROLLER 114 AND SWITCH 116 TO REDUCE THE IMAGE SIZE**
IS THIS IMAGE LOCKED FOR LATER DISPLAY?**
FLAG 1 (LOCKED) FIG 15, 16
YES
NO
FLAG 2 (TRANSMIT AFTER) FIG 15, 16
SHOULD IMAGE BE TRANSMITTED TO IMAGE PROCESSOR 104?**
NO
YES
DIGITIZE AND STORE THE IMAGE BY WRITING TO THE CONTROL REG 120 THE IMAGE AND SET FLAG TO INDICATE THE IMAGE WAS TAKEN.**
BUILD COPY MESSAGE AND SEND TO COPY PROCESS**
COPY PROCESS FIG 16
INCREMENT THE CURRENT CAMERA**
HAVE ALL FOUR CAMERAS BEEN PROCESSED?**
NO
YES
** THIS STEP IS REPEATED FOR EACH IMAGE DIGITIZER 32a–32d

FIG 15

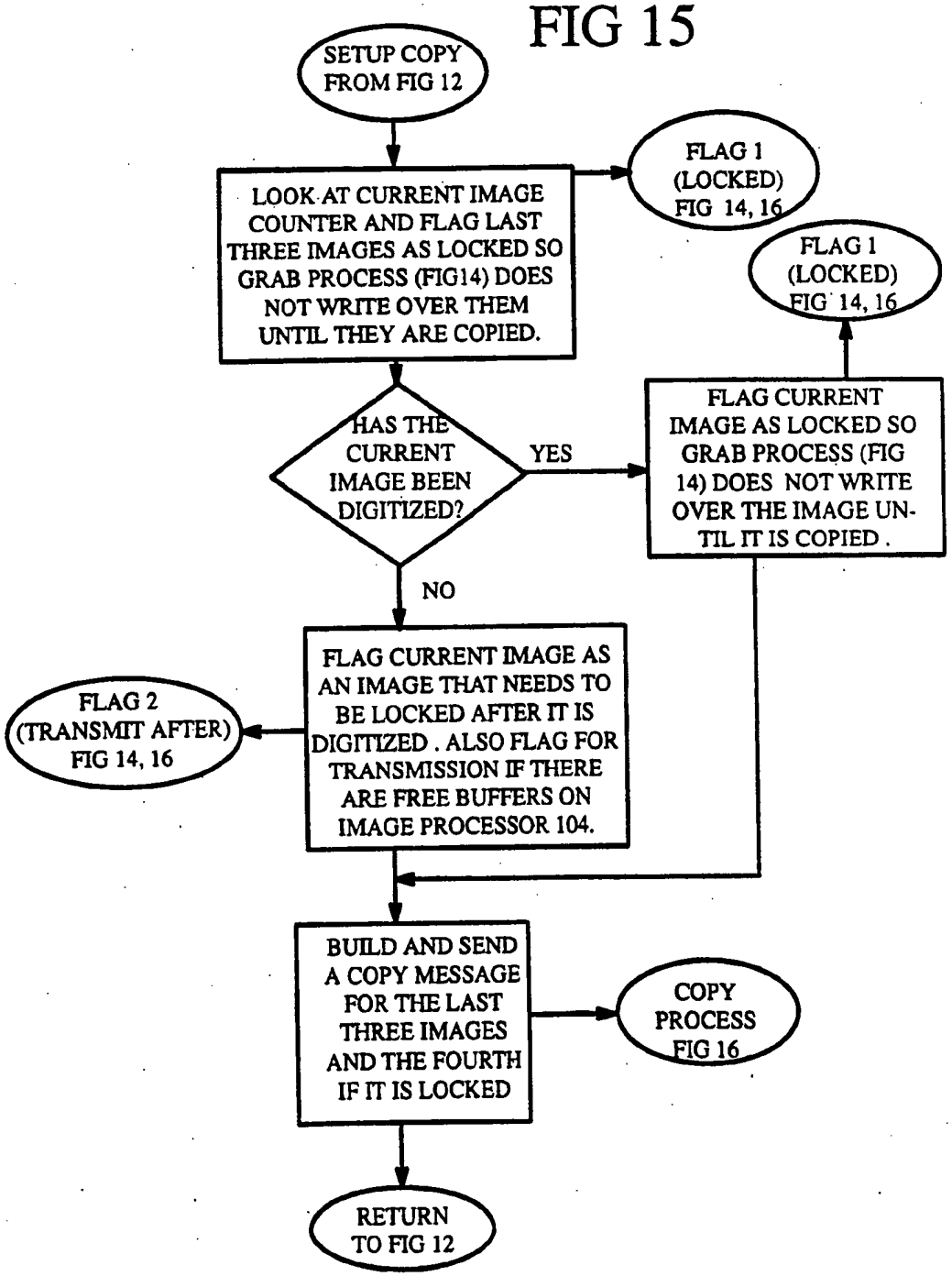
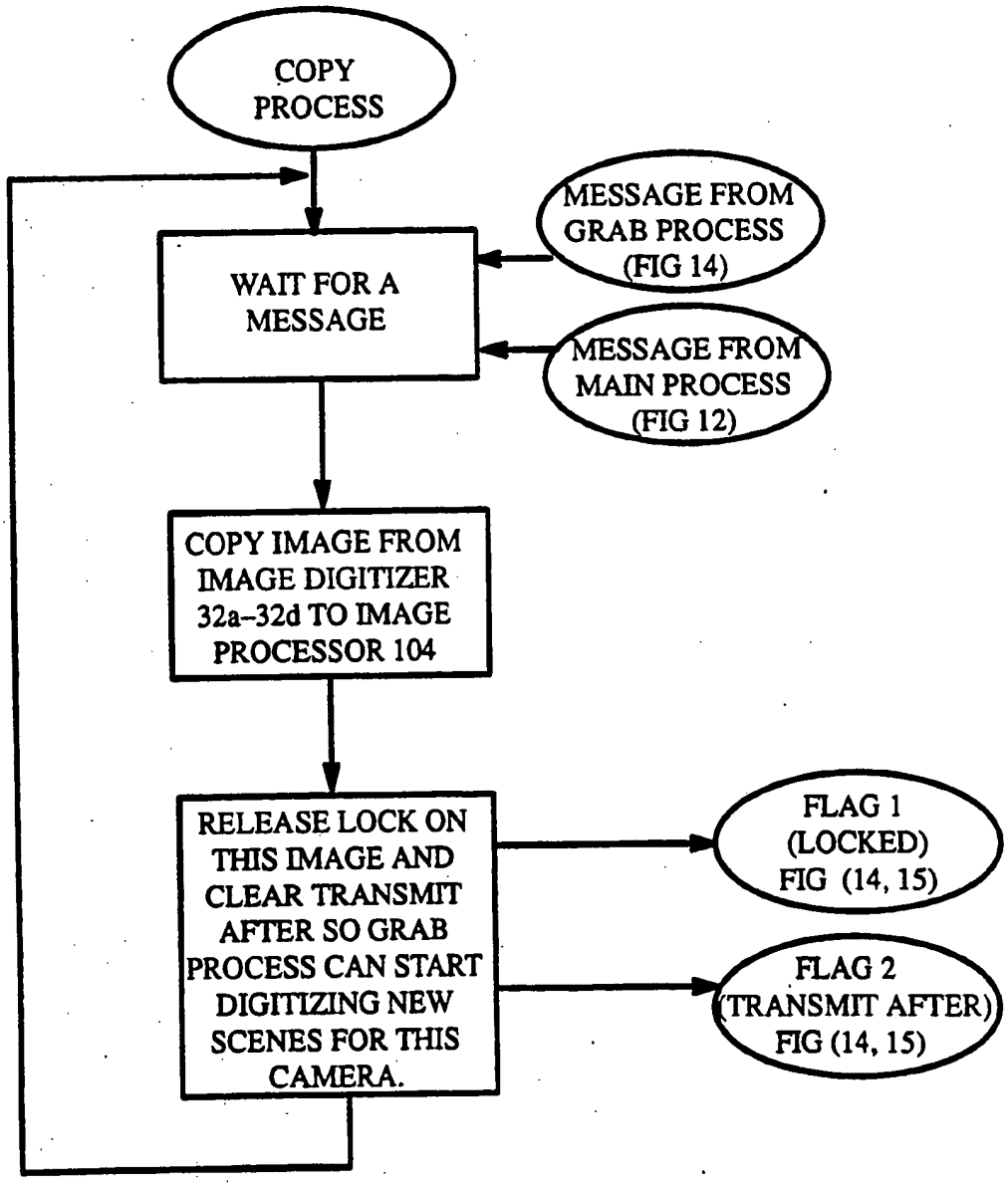

SETUP COPY FROM FIG 12
LOOK AT CURRENT IMAGE COUNTER AND FLAG LAST THREE IMAGES AS LOCKED SO GRAB PROCESS (FIG14) DOES NOT WRITE OVER THEM UNTIL THEY ARE COPIED.
FLAG 1 (LOCKED) FIG 14, 16
FLAG 1 (LOCKED) FIG 14, 16
HAS THE CURRENT IMAGE BEEN DIGITIZED?
YES
FLAG CURRENT IMAGE AS LOCKED SO GRAB PROCESS (FIG 14) DOES NOT WRITE OVER THE IMAGE UNTIL IT IS COPIED.
NO
FLAG CURRENT IMAGE AS AN IMAGE THAT NEEDS TO BE LOCKED AFTER IT IS DIGITIZED. ALSO FLAG FOR TRANSMISSION IF THERE ARE FREE BUFFERS ON IMAGE PROCESSOR 104.
FLAG 2 (TRANSMIT AFTER) FIG 14, 16
BUILD AND SEND A COPY MESSAGE FOR THE LAST THREE IMAGES AND THE FOURTH IF IT IS LOCKED
COPY PROCESS FIG 16
RETURN TO FIG 12

FIG 16



10/02/2003, EAST Version: 1.04.0000

FIG 17a

t=n–3i–3x	t=n–2i–3x
t=n–i–3x	t=n–3x

Buffer 1 Camera 1 Images

t=n–3i–2x	t=n–2i–2x
t=n–i–2x	t=n–2x

Buffer 2 Camera 2 Images

t=n–3i–x	t=n–2i–x
t=n–i–x	t=n–x

Buffer 3 Camera 3 Images

t=n–3i	t=n–2i
t=n–i	t=n

Buffer 4 Camera 4 Images

FIG 17b

t=n+i–3x	t=n–2i–3x
t=n–i–3x	t=n–3x

Buffer 1 Camera 1 Images

t=n+i–2x	t=n–2i–2x
t=n–i–2x	t=n–2x

Buffer 2 Camera 2 Images

t=n+i–x	t=n–2i–x
t=n–i–x	t=n–x

Buffer 3 Camera 3 Images

t=n+i	t=n–2i
t=n–i	t=n

Buffer 4 Camera 4 Images

FIG 18a

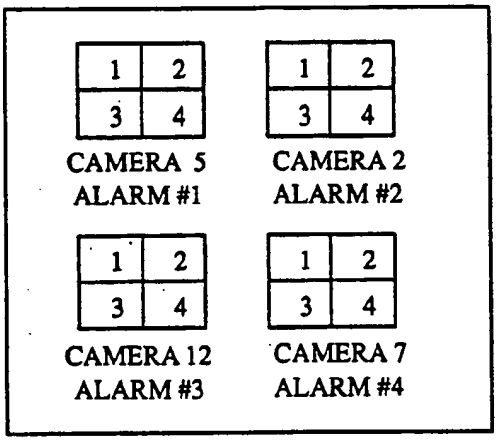
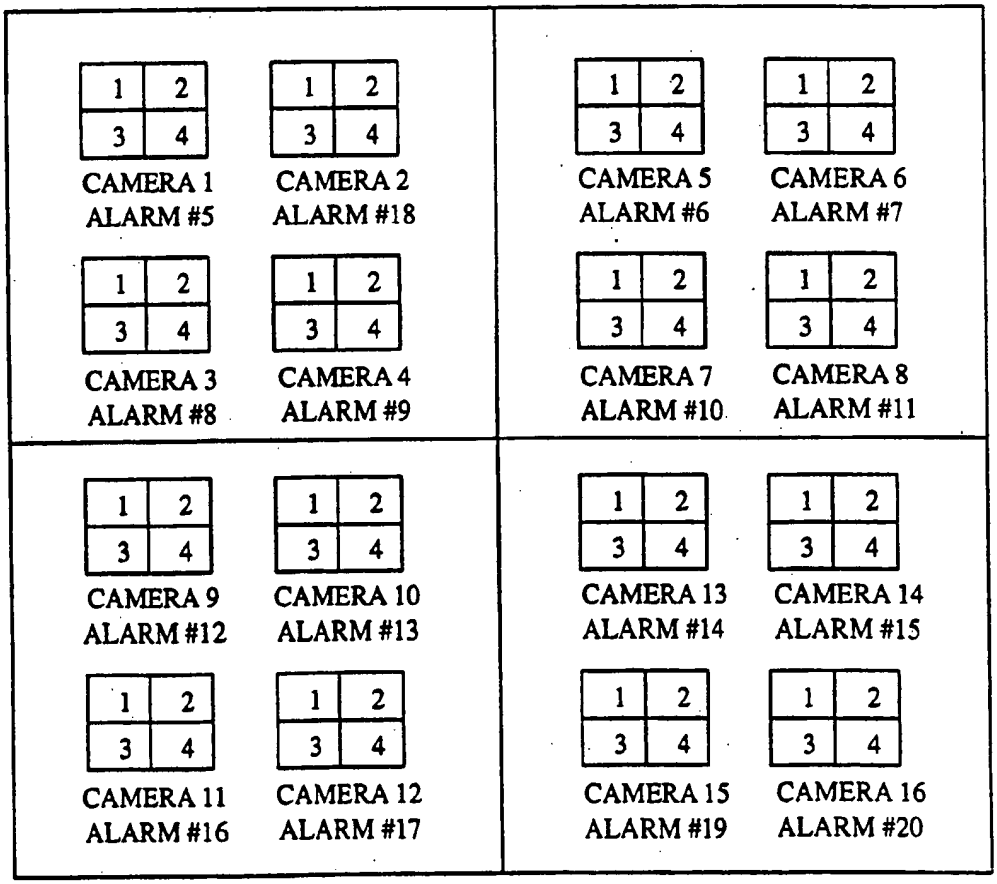


FIG 18b



AUTO FREEZE FRAME DISPLAY FOR INTRUSION MONITORING SYSTEM

This is a continuation, division, of application Ser. No. 07/548,847, filed Jul. 6, 1990.

IDENTIFICATION OF APPENDICES

Appendices A-E form part of this specification. These Appendices include material which is subject to copyright protection. The copyright owner has no objection to the facsimile reproduction by anyone of the patent disclosure, as it appears in the Patent and Trademark Office patent files or records, but otherwise reserves all copyright rights whatsoever. Appendices a through E are in the form of a microfiche appendix, having a total number of 12 microfiche and a total of 394 frames.

BACKGROUND OF THE INVENTION

This invention relates to a monitoring system that automatically displays still images related to an intrusion alarm in order to enhance the ability of security personnel to assess the nature of the alarm.

Intrusion detection systems are widely used to control and monitor access to sensitive areas such as for example commercial nuclear generating stations Typically, such detection systems will monitor a perimeter divided into zones. Each zone will have one or more sensors designed to detect intrusion into the zone as well as one or more video cameras positioned to observe an intruder who has triggered a sensor in the respective zone.

FIG. 1 shows a schematic representation of one such prior art intrusion detection system. The system of FIG. 1 monitors a portion of a perimeter which includes three zones: Zone 1, Zone 2, Zone 3. Each of the zones is at least partially defined by a respective one of two perimeter fences 10, 12. As shown in FIG. 1, three sensor systems S1, S2, S3 monitor the respective zones and each of the sensor systems S1, S2, S3 generates a respective alarm signal Al. A2. A3 when triggered. The sensor systems S1, S2, S3 may include either active sensors, passive sensors, or some combination. Active sensors such as microwave sensors detect intrusions by sensing changes in an energy field generated by the sensor. Passive sensors, such as heat detectors sense intrusions by detecting environmental changes such as the heat associated with a person or other intruder. Further details on such sensors may be found in R.L. Barnard. *Intrusion Detection Systems* (2nd Edition. 1988) at pages 19-21.

The system of FIG. 1 further includes a number of video cameras VC1-VC6 that generate respective video signals V1-V6 In the illustrated system there are two video cameras associated with each of the zones, and the video cameras may be positioned either inside or outside the respective zone. Any number of cameras may be used to cover a zone, depending upon the physical characteristics of the zone and good security practice. and the number of video cameras used per zone may be either greater or lesser than the number shown in FIG. 1. The cameras may be any conventional video camera that generates a standard RS17O signal. However, higher quality cameras will generate better pictures because they operate with a greater bandwidth that allows more levels of gray to be used in the final digitized picture described below.

In the past, intrusion detection systems have been used in which a central control system automatically responds to the alarm signals A1-A3 to record on video take the video signals V1-V6 associated with the zone in which the intrusion was detected. The security guard is then expected to rewind the video cassette recorder to view the zone at the time of the intrusion This approach relies on the security guard to rewind the VCR and to view the recorded video images for each alarm. In the event there are a number of false alarms, the security guard may not always choose to complete the time consuming job of rewinding the VCR and then watching it. Furthermore, a VCR that stores a conventional video image is not well suited to record quickly changing scenes. In the event of a moving car passing through a zone. only a few frames may have sufficient detail to allow details such as the license number of the car to be seen.

Another problem encountered with previous video monitoring systems is that in the event of multiple alarms the first alarm may impede or prevent the security guard from viewing video information regarding subsequent a)arms. This weakness can be exploited by false alarms which may delay or prevent the security guard from seeing the real intrusion.

Yet another problem of certain prior art intrusion detection systems is related to the fact that alarm signals may not be reported at the central station promptly. In this case. a quickly changing scene may have changed substantially before the controller can begin to record video signals from the appropriate video cameras. When this happens, critical information that would be useful to a security guard in assessing an alarm is irretrievably lost.

Accordingly it is a primary object of this invention to provide an improved intrusion detection system which automatically displays still video images of a zone associated with an alarm to allow a security guard to assess the alarm.

It is a further object of this invention to provide such a system in which multiple still video images corresponding to multiple successive alarms are stored and readily accessible to a security guard. This allows the security guard to view still video images associated with successive alarms quickly and easily.

It is another object of this invention to provide such an intrusion detection system which stores still video images associated with an alarm prior to reception of the alarm by a central control system for automatic retrieval and display in the event of an alarm.

It is another object to provide such a system in which the magnification and contrast of the displayed video images can be adjusted easily by a security guard.

SUMMARY OF THE INVENTION

This invention relates to improvements to an intrusion alarm system of the type comprising means for generating a plurality of alarm signals, each associated with a respective zone, means for generating a plurality of video signals, each associated with a respective zone, and means for transmitting the video signals and the alarm signals to a central station.

According to a first aspect of this invention, at least one video image digitizer is situated at the central station and is operative to store at least one digitized still video image. A controller, also situated at the central station, is responsive to the alarm signals to apply selected ones of the video signals to the image digitizer

such that promptly after one of the alarm signals is generated the respective video signal is automatically applied to the image digitizer. A display is coupled to the image digitizer to display the digitized video image stored by the image digitizer, thereby automatically presenting to an operator a still video image of the zone associated with an alarm, taken at a time immediately after the alarm.

According to a second feature of this invention, at least one video image digitizer is situated at the central station and operative to store a plurality of sets of digitized still video images on an ongoing basis, each set associated with a respective one of the video signals, each stored digitized still video image corresponding to a respective image time. A controller is situated at the central location and is responsive to the alarm signals to automatically select at least one of the stored digitized still video images for display. The selected stored digitized still video image corresponds for each of the alarm signals to the zone associated with that alarm signal, and to an image time prior to the time the respective alarm signal was received by the controller A display is coupled to the video image digitizer to automatically display the selected stored digitized still video image, thereby automatically providing a security guard with a view of the zone associated with an alarm signal as the zone appeared at a time prior to the time when the alarm signal was received by the controller.

The preferred embodiments described below reduce the workload of security personnel by completely eliminating the need to rewind a VCR to view a zone in which a sensor has generated an alarm. This is because the corresponding video signals are automatically digitized and automatically displayed as still images. The systems described below automatically record multiple still video images associated with subsequent alarms, and thereby ensure that a first alarm will not immobilize the system and prevent it from recording information related to subsequent alarms. The second preferred embodiment disclosed below records still video images on an ongoing basis. When an alarm is received, the controller selects a previously recorded still video image in the zone corresponding to the alarm and displays a still video image of the zone prior to the time the alarm was actually received by the controller. This feature is of particular importance when the delay between the generation of the alarm by the respective sensor and the receipt of the alarm by the controller is relatively long.

The invention itself, together with further objects and attendant advantages, will best be understood by reference to the following detailed description, taken in conjunction with the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic representation of a sensor and video camera arrangement of a prior art intrusion detection system.

FIG. **2** is a block diagram of a first preferred embodiment of this invention.

FIG. **3** is a more detailed block diagram of one of the image digitizers of FIG. **2**.

FIGS. **4–8** are flow charts of programs executed by the computer of FIG. **2**

FIG. **9** is a block diagram of a second preferred embodiment of this invention.

FIG. **10** is a more detailed block diagram of one of the image digitizers of FIG. **9**.

FIG. **11** is a more detailed block diagram of the image processor of FIG. **9**.

FIGS. **12–16** are flow charts of programs executed by the computer of FIG. **9**.

FIGS. **17***a*, **17***b*, **18***a*, **18***b* are schematic representations of stored still video images in the embodiment of FIG. **9**.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

Turning now to the drawings. FIG. **2** shows a block diagram of a first preferred embodiment **20** of the monitoring system of this invention. The monitoring system **20** includes a computer system **22** that responds to alarm signals A1–An of the type described above in conjunction with FIG. **1** and video signals V1–Vm of the type described above in conjunction with FIG. **1** In this embodiment there are two video signals for each alarm signal, as in the arrangement of FIG. **1**. In general terms, the computer system **22** responds to one of the alarm signals by selecting the pair of video signals associated with the alarm signal digitizing the selected video signals, and then automatically presenting the resulting still video images on a CRT for viewing by a security guard. As described below, the guard can control magnification and contrast of the displayed still video images, and can also view images associated with subsequent alarms on request.

As shown in FIG. **2**, the computer system **22** includes a bus **24** that interconnects the various components of the computer system **22**, including a computer **26** and related components **28–36**, as described in detail below. All of the components **26–36** are preferably mounted: in a single computer chassis to reduce the cost and size of the system.

The bus **24** is preferably a high speed interfacing system which is used to interconnect data processing, peripheral control and data storage devices in a closely coupled hardware configuration. The preferred embodiments employ a bus that ses 16 bit transfers at a rate of 20 megabytes per second. A bus using 32 bit transfers at a rate of 40 megabytes per second may be used as well, as buses with higher transfer rates. Use of this high speed bus to interconnect the computer **26** and related components **28–36** results in a monitoring system **20** that transfers data and control sign3is at a speed well suited to an intrusion monitoring system.

Many existing intrusion monitoring systems use a low speed RS-232 serial-communication link which requires each individual component to have its own processor or controller. These processors or controllers provide an interface between data processing elements and the RS-232 link. Use of a high speed bus **24** reduces the complexity of the monitoring system by eliminating controllers. Further, because all related components **28–36** are directly accessible by one processor, the computer system **22** with bus **24** allows a reduction in the number of instructions to the computer **26**. Therefore, communication with other related components **28–36** by the computer **26** is performed directly using several lines of code rather than indirectly using hundreds of lines of code. Thus, the computer system **22** provides a dual savings in communication time as the shorter instruction set can be processed faster and a higher transfer rate is available.

Use of bus **24** also allows the computer system **22** to make use of very high speed transponders, such as discussed below, without introducing additional delays.

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A number of inputs are provided to the computer system 22 as follows The video signals V1-Vm are supplied in parallel to a video multiplexer 30 which communicates with the computer 26 via the bus 24. Under computer control. the multiplexer 30 selects two of the video signals V1-Vm and supplies them to respective ones of the two image digitizers 32. The image digitizers 32 are conventional devices explained in greater detail in conjunction with FIG. 3 which operate to take a single video frame, digitize it and store it for later display. Image digitizers may on occasion be referred to as "frame grabbers".

A second set of inputs to the computer system 22 is the alarm signals A1-An such as those described above in conjunction with FIG. 1. The alarm signals A1-An can take many forms. The computer system 22 is designed to receive the alarm signals A1-An in any one of three forms. The transponder 38 is coupled to a bus interface 28 and operates as a multiplexer to sense any change in state of any of the alarm signals and to report an alarm to the computer 26, in this case via an INTEL pulse width timed transmission (XFER). The transponder 38 can be referred to as a VME/XFER alarm transponder. Alternately the alarm signals A1-An may be applied to the computer system 22 via a serial transponder 40. Thirdly, the alarm signals A1-An may be applied as dry contact switches to an analog/digital input card alarm transponder 36 which is mounted on the bus 24. Depending upon the security system used, all three types of transponders 38, 40, 36, or any combination thereof may be used to supply alarm information to the computer 26. Of course. other signal protocols and associated transponders may be substituted if desired.

The third input to the computer system 22 is supplied by a keypad 50 via a keypad interface 4S coupled to the bus interface 28 The keypad 50 is a 16 key device having ten keys for the digits 0-9 and six keys marked as shown in FIG. 2 and described below. The keypad 50 is used by the operator in controlling the contrast. magnification and identity of the displayed screen.

The fourth input to the computer system 22 is supplied by operator terminal 52 used by an operator in housekeeping operations such as in programming the computer 26 to associate the video signals V1-Vm with respective ones of the alarm signals A1-An.

As shown in FIG. 2, the computer system 22 has two video outputs which drive two CRTs 42. The screen shown on either of the CRTs 44 may be selected via video switch 44 for printing, by a video printer 46.

The operation of one of the image digitizers 32 will be described in conjunction with FIG. 3. The digitizer 32 receives a video signal from the video multiplexer 30 as described above. This video signal is applied to an A/D converter 60 which digitizes the video signal and supplies the digitized result to an input look-up table (LUT) 62. The look-up table 62 is linearly programmed to assign a digital value indicative of the brightness of the associated portion of the video signal. In this case, the look-up table 62 uses one of 256 values, with black being assigned a value of 0 and white being assigned a value of 255. The output of the look-up table 62 is applied via a zoom and pan controller 70 and a switch 64 to one of four buffers 66 for storage. Each of the buffers 66 stores a single frame of video information in this embodiment.

When one of the frames of video information in one of the buffers 66 is to be displayed, the respective buffer 66 is selected via a switch 68, and the stored digital information is applied via the zoom and pan controller 70 and a switch 72 to one of eight output look-up tables 74. The zoom and pan controller 70 controls the magnification of the displayed screen. The output look-up tables 74 determine the contrast of the displayed screen. Each of the output look-up tables 74 stores a separate table. Typically, zone will be programmed as a linear look-up table, others will be programmed to improve the visibility of objects in a dark screen, and others will be programmed to improve the visibility of objects in a light screen. The output of the selected look-up table 74 is then applied via a D/A converter 76 to the respective CRT 42. The control register 78 is used for control functions and to select respective components.

Having described the structure of the monitoring system 20, its operation will now be explained in conjunction with the flow charts of FIGS. 4-8.

As a preliminary matter, before the monitoring system 20 goes into service the operator terminal 52 should be used to assign individual ones of the video signals V1-Vm to individual ones of the alarm signals A1-An. This can be done for example in using the Operator Process of FIG. 7. As shown in FIG. 7, the Operator Process waits for a keyboard command from the operator terminal 52. If the command is an assignment, the process assigns the selected video signal V1-Vm to the selected alarm signal A1-An in a configuration table maintained by the computer 26 If the keyboard command is a deletion, the selected video signal V1-Vm is deleted from the configuration table. If the keyboard command is an inactivation, an entire zone is marked as inactive in the configuration table. and alarms from that zone are ignored. Finally, if the keyboard command is an activation, the respective zone is marked as active in the configuration table. Thus, the configuration table associates individual ones of the video signals V1-Vm with individual ones of the alarm signals A1-An. Typically, the one or more video signals associated with any alarm are generated by one or more cameras focussed on the region monitored by the respective sensor.

As shown in FIG. 4, the Main Process executed by the computer 26 begins by waiting for a message. The two types of messages implemented in this system are keypad messages (FIG. 6) and alarm messages (FIG. 5).

As shown in FIG. 5, the Alarm Process executed by the computer 26 waits for an alarm signal from one of the transponders. Depending upon the transponder, this may be done either by polling the transponder repetitively, or by waiting for an interrupt generated by the transponder. Once an alarm has been received from one of the transponder, the Alarm Process then looks up the assigned zone number for the received alarm signal in the configuration table. The process then checks to determine whether the signal received was a reset and not an alarm. If so, the process returns to await a next alarm signal Next, the process checks to determine whether the zone for the received alarm has been inactivated. If so, the process returns to await a next alarm signal. Otherwise (if the zone has not been inactivated and the alarm is not reset) the process builds and sends an alarm message to the Main Process of FIG. 4 Thus, an alarm message will be automatically generated whenever one of the alarm signals Al-An indicates a new alarm in an active zone.

The Keypad Process shown in FIG. 6 begins by awaiting a keypad command. Once a command is received an appropriate message is built for the Main Process of FIG. 4 As shown in FIG. 4. this message

may be a clear message, a contrast adjustment message, a zoom message, or an alarm message. The Keypad Process responds to manual call up command by building an alarm message for the requested zone. Once the appropriate message has been built, the message is sent to the Main Process of FIG. 4.

Returning to FIG. 4, when an alarm message is received (which as explained above may be generated by either the Keypad Process or the Alarm Process) the Digitize Routine of FIG. 8 is called. As shown in FIG. 8, the Digitize Routine first selects the two video signals corresponding to the zone of the new alarm message The routine then checks to determine whether all of the buffers 66 are full. If so, an error message is sent to the operator terminal and no further action taken. Assuming one or more of the buffers 66 is available for use in each image digitizer 32, a buffer 66 is selected and an entry is made into the control register 78 of each image digitizer 32 to digitize the selected video signal V1–Vm via the A/D converter 60 and the input look-up table 62 and to store the digitized frame in the selected buffer 66. Once a video frame for each of the two video signals corresponding to the current alarm has been stored in one of the buffers 66 of each of the image digitizers 32, the routine of FIG. 5 then checks to determine whether there currently are unacknowledged alarms currently being displayed on the CRTs 42. If so, the routine returns to the Main Process of FIG. 4 Otherwise, if the CRTs 42 are free, a non-zoom value is set for the controller 70 and the linear output look-up table 74 is selected and then the D/A converter 76 is activated to display the stored video frames in the buffer 66 for the current alarm (with no magnification and with standard contrast) on the CRTs 42. If a previous alarm is being displayed, the Digitize Routine resets the zoom and pan logic controller 70 to the value it had prior to the most recent alarm in order not to override any previously requested magnification factor. Once this is accomplished. the routine of FIG. 8 returns to the Main Process of FIG. 4.

If the Main Process of FIG. 4 determines that the message is not a new alarm, it then checks to determine whether the message is n contrast adjustment command If so, the contrast is adjusted by selecting a different output look-up table 74 on the requested image digitizer 32. As pointed out above, depending upon the overall brightness or darkness of the digitized image, various ones of the non-linear output look-up tables 74 can be used to enhance visibility of unusually dark or unusually bright portions of the screen.

The Main Process of FIG. 4 then checks to determine whether the command is a zoom adjustment command If so, the zoom is adjusted by selecting a different value for the controller 70 on the requested image digitizer 32

Finally, the Main Process checks to determine whether a message is a c)ear command. If so, the image being displayed on the selected CRT 42 is cleared, and the next stored image from the associated image digitizer 32 is automatically displayed, if there are any.

The Digitizer Routine controls the video multiplexer 30 to apply the selected pair of the video signals Vl-Vm to the image digitizers 32 The video multiplexer 30 preferably has a high switching speed for video signals such that the switching delay caused by the video multiplexer is less than 10 microseconds, and preferably less than 0.5 microseconds. A preferred video multiplexer 30 is shown in Appendix B, which provides such high switching speeds. This multiplexer has provisions for 32 input video signals plus one external input that can be used for a 33rd video signal, or for cascading inputs from another multiplexer to allow one of more than 32 video signals to be selected for output. The video multiplexer of Appendix B allows up to four video signals to be supplied as outputs, though only two channels are used in the system of FIG. 2. The video multiplexer of Appendix B utilizes a standard 6u VME slave interface and a switch selectable VME A16 or A24 address. The selection/switching delay is under 10 microseconds and has been observed to be as low as 0.5 microseconds. This video multiplexer does not load existing video signals, thus enabling the multiplexer to be easily installed with existing systems.

As shown in FIG. 2, each video signal being digitized at a time requires a separate image digitizer 32. Thus, if only one video camera is provided for each zone, only one image digitizer 32 is required. Similarly, four image digitizers are required if four video cameras are provided for a zone and it is desired to digitize images from all four of these cameras simultaneously The only limit on the number of cameras per zone is good security practice.

The image digitizer 32 includes four buffers 66 in this embodiment, but other equipment can be used if more buffers are required. Additionally, frames may be saved by copying digitized screens that have not been displayed from the buffers 66 onto the memory board 34 via the bus 24. Once this has been done, the computer 26 can then flag the buffer 66 as available for use in storing subsequent video screens. The copied frames can be moved back from the memory board 34 for display when requested by the operator. Furthermore, disc storage may be used to greatly increase the number of images stored. In this embodiment, the controller 70 is always set to a non-zoom value when a frame is stored in one of the buffers 66 to indicate that a full 512 by 480 element image is to be stored.

Returning to FIG. 2, after an alarm has been serviced by the computer system 22, the scene as observed by the video cameras in the alarmed zone at the time the alarm was received is now frozen on the CRTs 42. The total elapsed time for camera selection, image digitization and display is approximately 1/15th of a second. Two CRTs 42 are used in this embodiment because two video cameras are used for each zone. In general, the number of CRTs 42 used preferably equals the number of cameras monitoring each zone in order for an operator to make a fast assessment of the situation. However, other display methods such as stacking the digitized images or combining the images from multiple cameras onto a single CRT may be used in alternate embodiments. The total time between the tripping of an alarm and the display of the frozen video signal can be up to one hundred milliseconds, depending upon the type of transponder used. This response time is acceptable for most intrusion alarm systems. As a major use of this system is to add a video capture function onto an existing system, any commercial transponder that allows response within this time range is generally acceptable.

Once digitized images have been displayed for the operator on the CRTs 42, the operator can print either or both of these images using the selection switch 44 and video printer 46. To better assess an intrusion, the operator may enhance a displayed image by adjusting contrast or by magnifying a portion of the displayed image, or both. These features are especially useful in

detecting intrusions in shadowy areas where existing systems have detection problems.

The operator can control contrast and magnification of the displayed images with the specially designed keypad **50** shown in FIG. **2**. The keypad **50** is connected to a keypad interface **48** which scans the keypad **50** to determine which keys are depressed. The keypad interface converts keypad signals to XFER protocol, and transmits the XFER protocol message to the bus interface **28**. The keypad commands are transmitted via the bus interface **28** to the computer **26**. These keypad commands activate the Keypad Process shown in FIG. **6** and discussed above Details of the presently preferred keypad **50** and interface **48** are shown in attached Appendix C.

If the operator wishes to magnify a section of a displayed image, he indicates which CRT **42** is displaying the screen he wishes to magnify. He also indicates which portion of the image he wishes to zoom in on. In the system **20**, the digitized image is divided into nine sections, and the operator chooses one of these nine sections using the keypad **50**. The keys AZ and BZ select the zoom feature for the two CRTs **42**, respectively, and the keys **1–9** select the section to be zoomed in on. The keys **1–9** are laid out to represent the nine screen sections that may be enlarged. Thus, key **1** will zoom in on the upper left hand corner of the screen while key **5** will zoom in on the center ninth of the screen and key **9** will zoom in on the lower right hand corner of the screen. The 0 key restores the zoomed image to its original magnification. Once a zoom command is sent, it is processed by the Keypad Process and the Main Process as described above.

Contrast adjustments are made in a similar manner. The keypad keys AC and BC select contrast adjustment for the A and B CRTs **42**, respectively, and the keys **1–7** select one of the 7 non-linear look up tables **74**. In the example of FIG. **3**, one of the look-up tables **74** is a standard linear lookup table for normal contrast. The remaining seven are non-linear look-up tables used to enhance contrast in either unusually light or unusually dark portions of an image. In contrast adjustment the keys **1–7** are used, with key **1** making light images darker and key **7** making dark images lighter.

Contrast adjustment is accomplished by changing the values assigned to the 256 possible shades of grey. If for example a uniformly dark image is displayed using the linear look-up table it will contain only the lower numbered shades with little visual contrast. However, if the same image is displayed using one of the pre-programmed nonlinear look-up tables, all dark values 0–64 can be assigned four times their original value, while all values **64–255** can be assigned the value **255**. Thus. the dark areas will be transformed into a full scale of grey while the lighter areas will be shown as white.

The operator may also clear a CRT with the CLR key on the keypad **50** as discussed above in FIG. **4**. This function is used when the system receives multiple alarms. If for example the sensors in Zone **2** sense an intrusion before the operator has acknowledged an alarm in Zone **1** and cleared the CRTs **42** of the stored video images, the video images from the cameras associated with Zone **2** will not be displayed immediately but will be stored in the buffers **66**. Additional digitized images from additional alarms will be stored until all of the buffers **66** are filled, or until the operator releases a prior alarm. When the operator clears a prior alarm with the keypad **50**, the previously displayed digitized images on the CRTs **42** are cleared, and stored video images from the buffers **66** are displayed in a first in, first out order. This is done by the Main Process of FIG. **4** as described, which clears the present image and displays a next image stored in the buffets **66** (if there is one) in response to a clear message.

The keypad **50** can also be used by the operator to command the display of digitized screens from the video signals V1-Vm corresponding to any particular one of the zones. This is done simply by pressing the two number zone assigned to the video cameras of interest.

The RE key is a reset key that can be used to delete an erroneous entry.

The keypad described above allows an operator to change the contrast or the magnification by depressing only two keys. However, other keypads can be used to accomplish the same function if desired.

If more than two cameras are used per zone, the keypad **50** may be modified to select additional CRTs **42** Additionally, a keypad using more than two entries per command may be used. Of course, if the system is designed to have more than 7 non-liner output look-up tables **74** or more than g zone segments the keypad **50** may be modified as appropriate. Finally, the presently preferred image digitizers allow for magnification of two times the original magnification. If other image digitizers are used which have a larger number of magnification levels, the keypad may be modified to add a variable zoom feature.

In order fully to define the presently preferred embodiment of system **20**. Table **1** defines presently preferred components for various elements of FIG. **2**. Note in particular that the bus interface **28**, the video multiplexer **30** and the keypad **50** and interface **4S** are shown in complete detail in Appendices A–C. Furthermore, Appendix D provides software for the software driven components of the system **22**, including the computer **26**, the interface **28** and the keypad interface **48**. Appendix E provides further information regarding hardware and connection configurations for hardware using the software of Appendix D. Of course, this detailed information is not intended in any way to limit the scope of this invention, but is merely being provided to define the presently preferred embodiment of this invention.

TABLE 1

REF. NO.	FUNCTION	IDENTIFICATION
24	Bus	Dawn VME Products 12 Slot VMEbus Chassis 11-1002920 (Fremont, CA)
26	Computer	Motorola MVME 104/105/106/107
	Operating System	Software Components Group, Inc. PSOS Rev. 4.13 (San Jose, CA)
	Assembler	Oasys Corp. linker 68000 LINKER, Version 4.12
	Linker	Oasys Corp. assembler 68020/881 ASSEMBLER, Version 2.12
	C Compiler	Oasys Corp. cross-compiler Rev. 7.11
28	Bus Interface	See Appendix A
30	Video Multiplexer	See Appendix B
32	Image Digitizer	Matrox Model VIP-1024A (Dorval, Canada)
34	Memory Board	
36	Transponder (A/D Input Card)	ACROMAG AVME 9480 (Wixom, Mich.)
38	Transponder	Commonwealth Edison

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TABLE 1-continued

REF. NO.	FUNCTION	IDENTIFICATION
		APARS Field Board
40	Transponder (Serial)	Sygetron Remote Multiplexing Unit
46	Video Printer	Mitsubishi Model P71U
48, 50	Keypad and Interface	See Appendix C
52	Operator Terminal	WYSE 60

As an alternative to a separate computer, operating system and compiler, a computer may be obtained with the PSOS operating system on PROMS from Io Incorporated of Tucson Arizona. Io also supplies a C compiler. Alternative software operating systems and C library may be used. Microware Systems Corporation of Des Moines. Iowa supplies similar software under the name of OS-9 TM which should prove suitable for this application.

SECOND PREFERRED EMBODIMENT

As pointed out above, in some existing security systems an alarm is not received by the central station until a considerable delay after the alarm was triggered. When this is the case, if the controller freezes a video frame only after it receives an alarm, the frozen video frame may not assist in interpreting the alarm In particular, if the delay between the triggering of the alarm and the freezing of the video frame is too great, an intruder may have left the field of view of the respective camera. It can be quite expensive to install a higher speed alarm reporting system, and the second preferred embodiment **100** of the monitoring system of this invention overcomes this problem.

The monitoring system **100** is shown in block diagram form in FIG. **9**. In this embodiment. the system **100** includes a computer system **102** which utilizes many of the same hardware component, as discussed above in conjunction with FIG. **2**. Where this is the case the same reference numerals have been used, and the foregoing detailed description of these components should be referenced. In FIG. **9** the computer is indicated by reference numeral **26'** to indicate that it is programmed differently from the computer **26** of FIG. **2** The monitoring system **100** is designed for an application having one video signal V1-Vn for each alarmed zone, but the system can readily be modified for use with systems having more cameras per zone. The image digitizers **32***a*-**32***d* are each identical to the image digitizer **32** discussed above. Furthermore, the image process **104** can also be implemented using the same hardware as that used for the image digitizer **32** discussed above.

As before, the operator uses the operator terminal **52** to assign or delete cameras or activate or deactivate the video capture process for desired zones. Although any of the three transponder types **36**, **38**, **40** may be used, it will often be preferable to use the transponder **36** in the monitoring system **100** because of the ease of use, and the lower cost and complexity of interfacing the monitoring system **100** with existing security systems.

In the monitoring system **100** the video multiplexer **30** is used to send video signals to four image digitizers **32***a*-**32***d* simultaneously. The image digitizers **32***a*-**32***d* are configured differently from the image digitizer **32** discussed above, and FIG. **10** shows a block diagram of the digitizer **32***a*. A video signal received from the video multiplexer **30** is applied to an A/D converter **110**. The digitized output of the A/D converter **110** is applied as an input to an input look-up table **112**. The output of this look-up table **112** is then applied to a zoom and pan controller **114** and then via a switch **116** to one of four buffers **118**. In this embodiment the controller **114** reduces the magnification of the digitized video image such that four images can be stored in each buffer. Thus, the four buffers **118** store up to sixteen separate video images. If more than sixteen images are required, an additional video multiplexer and additional image digitizers may be used.

FIG. **11** shows a block diagram of the image processor **104** which also contains four buffers **130**, each of which can store up to four video images. Any one of the video images stored in the buffers **130** can be applied via a switch **132** to a zoom and pan controller **134** and then via a switch **136** to a selected one of eight output look-up tables **138**. The output of the selected look-up table **13B** is then applied via a D/A converter **140** to the CRT **42**.

The computer **26** is programmed to control the image digitizers **32***a*-**32***d* to digitize selected screens of the incoming video signals V1-Vn on an ongoing repetitive basis, regardless of whether or not an alarm has been received This function is controlled by the Grab Process flowcharted in FIG. **14**. In general, the Grab Process of FIG. **14** controls the video multiplexer **30** so that initially images from a set of four cameras (for example, video signals Vl. V5. V9. V13) are sent to the four image digitizers **32***a*-**32***d*, respectively. Approximately 0.08 second later, the Grab Process of FIG. **14** switches the video multiplexer **30** to send a second set of four video signals (for example, V2, V6, V10, V14) to the respective image digitizers **32***a*-**32***d*. This process is repeated approximately 0.08 second later for the third set of video signals (V3. V7, V11. V15) and approximately 0.08 second after that for the fourth set of video signals (V4, V8, V12, V16).

This embodiment is designed for use with sixteen video signals V1-V16. and in this embodiment the timing for the full cycle (in which a single video frame is digitized for each of the sixteen video signals V1-V16) is variable and is designated by the variable i. In this example, it is set at 0.50 second. However i may be set from a minimum (for this embodiment) of 0.32 second up to any interval that good security practice will allow. This timing is controlled by the Time Process shown in FIG. **13**.

The minimum full cycle time of 0.32 second in this example is the result of using sixteen video cameras with one video multiplexer **30** and four image digitizers **32***a***32***d*. The minimum full cycle time can be changed depending upon the number of these elements used. For example, when only four cameras are used with one video multiplexer and four image digitizers, the full cycle time can be reduced to 0.08 second. Eight cameras with the same equipment will allow a minimum full cycle time of 0.16 second. Similarly, maintaining sixteen cameras but increasing the number of video multiplexers to 2 and the number of image digitizers to 8 would also allow a minimum full cycle time of 0.16 second. A designer should balance the cost of the additional hardware against the requirements of the individual security system.

As shown in FIG. **10**, each video signal from the multiplexer **30** is digitized and then applied as an input to a look-up table **112** which is in this embodiment a linear look-up table as described above in conjunction

with the first preferred embodiment. Unless the buffers **118** are locked because they contain images from a previous alarm, the Grab Process of FIG. **14** selects a buffer **118** for data storage by writing the buffer number into the switch **116**. The Grab Process next sets the zoom and pan controller **114** to a zoom with a value that corresponds to the appropriate quadrant in the buffer **118** in which the digitized image will be stored. The stored image occupies a space of 256 by 240 elements instead of the full frame space of 512 by 480 elements. The Grab Process then uses the control register **120** to store the quadrant image as a 256 by 240 element digitized image in one quadrant of the respective buffer.

Over a full cycle one quadrant of all sixteen buffers **118** of the four image digitizers contain one **256** by **240** element digitized image for each video signal V1–V16. This process is repeated so that after four cycles (approximately 2 seconds in this example) the sixteen buffers of the four image digitizers each contain four 256 by 240 element digitized images from each camera. The images stored at time t=n in the four buffers **118** of one image digitizers **32***a*–**32***d* is shown in FIG. **17***a*. In FIG. **17***a*, i equals the time between successive images for a camera and x equals the software delay time to synchronize and digitize an individual image. In this example as explained above, i equals 0.5 second and x equals 0.08 second. FIG. **17***b* shows the pattern of stored images in the same buffers at the next cycle, at which t equals n+i. As shown in FIG. **17***b*, the Grab Process causes the digitized image generated in this next cycle at time t equals n +i to overwrite the oldest stored image. This process repeats on an ongoing basis with each new digitized image overwriting the oldest digitized image in a buffer until the computer **26'** receives an alarm signal or a request from the key pad **50**.

FIG. **12** shows a flow chart of the Main Process executed by the computer **26'**. The Main Process simply waits for a message from the key pad **50** or from the Alarm Process, both as described above in conjunction with the first preferred embodiment. Once a message is received, it is then checked to determine whether it indicates a new alarm. If so, the Setup Copy Routine of FIG. **15** is called, which sends a message to the Copy Process of FIG. **16**. The Copy Process in turn causes the last three images stored before the alarm or request to be transferred to a buffer **130** of the image processor **104** for storage and eventual display.

As shown in FIG. **15**, the Setup Copy Routine first flags the last three images from the camera associated with the alarm as locked so that the Grab Process does not overwrite them until they are copied. The process then checks to determine whether the current image from the respective camera has been digitized. If so, the current image is locked so that the Grab Process does not overwrite it until it has been copied. Otherwise, the current image is flagged as one that needs to be locked after it is digitized and the three locked images are flagged for transmission to the image processor **104**. Then a message is built and sent to the Copy Process for the last three images of the camera associated with the current alarm (and for the fourth image if it was already been locked).

The Copy Process is shown in flow chart form in FIG. **16**. This process waits for a message from either the Grab Process or the Main Process and then copies flagged images from one of the image digitizers **32***a*–**32***d* to the image processor **104**. After the images have been copied into the image processor **104** the lock is released on these images in the image digitizer so that the Grab Process can start digitizing new scenes for this camera.

As pointed out above, the Control Process for transmitting the fourth digitized image varies, depending on the time within the cycle when the alarm occurs. If the video signal for the camera corresponding to the current alarm has been digitized prior to the alarm being received by the computer **26'**, the fourth image is locked and the Copy Setup Process sends a message to the Copy Process to copy four digitized images from the buffers **118** to the buffers **130**. On the other hand, if the video signal from the camera associated with the current alarm has not yet been digitized when the alarm is received by the computer **26'**, then the Grab Process builds a copy message and sends that message to the Copy Process. The Copy Process then accomplishes the transfer for the fourth image as described above.

It should be apparent that this invention is not limited to the display of three 256 by 240 element images taken before an alarm or request is received and one **256** by **240** element image taken after the alarm or request if received. By changing the Setup Copy Process and the Grab Process one can display two pictures taken before the alarm and two after, or one taken before the alarm and three taken after. By properly selecting the cycle times and the number of images copied from times before the alarm was received by the computer **26'** one of the displayed images on the CRT **42** can be made to correspond in time approximately with the time the corresponding alarm was actually triggered (as opposed to the time the corresponding alarm was received by the computer **26'**).

Upon a second alarm or request, another set of four video images (three prior and one subsequent to the alarm or request) are transferred to a second buffer **130** in the image processor **104**. The second set of digitized images may be from the same or from a different camera as the first set of images. Third and fourth sets of digitized images may be stored in the buffers **130** in a similar manner. Once these four buffers are full only one additional set of images of the camera may be stored, with storage occurring in the respective image digitizer **32***a*–**32***d*. FIG. **18***a* shows the system where the first, second, third and fourth alarms occurred in the areas covered by camera **5**, camera **2**, camera **12**, and camera **7**, respectively. FIG. **18***a* indicates the contents of the buffers **130** of the image processor **104** in this condition. Only one further set of digitized images may be stored for each camera after this fourth alarm. The storage patterns for alarms **5**–**20** are shown in FIG. **18***b*, which represents the four buffers **118** of the four image digitizers **32***a*–**32***d*. Until images are released from the image processor **104** (and replaced by the next alarm images in sequence) no further images will be stored as the Grab Process locks and protects the buffers against further overwriting. Thus, one can see that no images would be stored after the twenty-first alarm. Furthermore, if the sixth alarm were from camera **1** rather than from camera **5**, no video images would be stored, because both the buffer assigned to camera **1** and the four buffers of the image processor **104** would be full.

When one of the buffers **130** of the image processor **104** receives a set of four images, corresponding to the first alarm, these imges are automatically displayed on the CRT **42**. Referring to FIG.**11**, the zoom and pan logic controller **134** is initialized to a non-zoom value to indicate that the output image will not be magnified. The digitized image passes via the switch **136** which has

been preinitialized to select the linear output look-up table 138, because no contrast adjustment has yet been selected. The set of four 256 by 240 element images are then automatically converted by the D/A converter 140 so that the four captured images are displayed as they are copied onto the CRT 42 in quadrant format.

In a manner similar to that described above in conjunction with the first preferred embodiment, the operator may enhance the displayed video picture by adjusting picture contrast, by magnifying one of the four images using the zoom feature, or both using the key pad 50 described above (FIG. 12). The only difference between the key pad in the two embodiments is that the key pad in the second embodiment does not need the keys for choosing between two CRTs 42. Of course, this feature would be used if the second embodiment were designed for use with a second image processor and a second display monitor.

If the operator wishes to magnify one of the four displayed pictures, he indicates which picture he wishes to zoom in on. When the Key Pad Process discussed above determines that the operator has sent a zoom command, the process builds a zoom message and sends it to the Main Process of FIG. 12. when the Main Process receives a zoom message from the key pad it writes a value into the zoom and pan logic controller 14 for the requested frame to indicate a zoom adjustment. The operator zooms in on the appropriate frame by a two key command. Depressing key AZ indicates a zoom and keys 1-4 indicate what frame (key 1 designates the picture in the upper left corner of the screen, key 2 the upper right, key 3 the lower left hand key 4 the lower right). Upon zoom activation the selected picture will be magnified to fill the entire screen. Keying in the two keys AZ, O will remove the zoom enlargement and restore the four quadrant display.

Contrast adjustments are performed in a manner similar to that of the first embodiment. The operator depresses the key AC followed by one of the keys 1-7 to vary the contrast as previously described. If the four picture set is displayed prior to contrast adjustment, the contrast will be changed for the set of four pictures. If a zoomed image of one picture is being displayed, only the contrast of that one picture will be adjusted. As before, depressing the key AC followed by the key O will remove contrast adjustment.

The CLR key will clear the video display and erase the set of four images from storage in the image processor 104. The RE key will clear the key pad commands in an event of a mistake as described above.

Also, as described above. the system 100 allows the operator to select from the key pad a camera to view. As before, the operator can depress the camera numbers 0-16 if he wishes to view the area for any reason As described above the Key Pad Process builds an alarm message for that camera and the images (three prior to the request and one following the request) are passed to the image processor 104 as described above.

The hardware used in the presently preferred embodiment is the same as that identified above in Table 1. With respect to software. Appendix D provides the presently preferred program for the computer 26' as well as the programs for the bus interface 28 and the keypad interface 48. Appendix E provides configuration and connection information for hardware. As before, this information has been provided merely to define the presently preferred embodiment of this invention. and is not intended to be limiting in any way.

CONCLUSION

From the foregoing, it should be apparent that improved monitoring systems have been disclosed which automatically display still video images corresponding to the zones of an alarm with a minimum of operator intervention. In these systems the operator needs only to clear one set of images to see the next. and no recorder rewinding is required. Furthermore, the systems are designed to store images for a plurality of alarms such that a first alarm does not prevent the system from recording still images for a second alarm. This enhances the reliability of the system. Finally, the second preferred embodiment functions particularly well with prior art sensor systems that report alarms slowly. Because video images are frozen on an ongoing basis the system allows still images to be displayed from about the time when the alarm was triggered, even though this triggering time was well before the time the alarm was received by the monitoring system.

Of course, it should be understood that a wide range of changes and modifications can be made to the preferred embodiments described above. A wide variety of computer hardware and software and a wide variety of video processing components can be adapted for use with this invention. As explained above, the number of zones, the number of sensors, the number of cameras, as well as the exact configurations of video processing equipment can all be adapted as appropriate for the particular application. It is therefore intended that the foregoing detailed description be regarded as illustrative rather than limiting, and that it be understood that it is the following claims, including all equivalents, which are intended to define the scope of this invention.

We claim:

1. In a video surveillance and intrusion alarm system of the type comprising means for generating a plurality of alarm signals, each associated with a respective zone; and means for generating a plurality of video signals, each associated with a respective zone; the improvement comprising:

at least one video image digitizer means for storing on an ongoing basis a plurality of sets of digitized still video images, each set associated with a respective one of the video signals, each stored digitized still video image corresponding to a respective image time;

controller means responsive to thee alarm signals for automatically selecting at least one of the stored digitized still video images for display, said at least one selected digitized still video image corresponding for each of the alarm signals to the zone associated with that alarm signal, and said at least one selected digitized still video image corresponding to an image time prior to the time the respective alarm signal was received by the controller means; and

display means coupled to the at least one video image digitizer means for displaying the at least one selected digitized still video image, thereby providing a view of the zone associated with an alarm signal as the zone appeared at a time prior to the time when the alarm signal was received by the controller means.

2. The system of claim 1 wherein the at least one video image digitizer means and the controller means are situated at a central station, wherein the alarm signals are transmitted to the central station with an aver-

age propagation delay, and wherein the at least one selected digitized still video image corresponds to an image time that precedes the time the respective alarm signal was received by the controller means by an amount selected to compensate for the average propagation delay such that the at least one displayed digitized still video image provides surveillance personnel with a view of the zone associated with the alarm signal at the zone appeared at about he time when the alarm signal was generated.

3. The invention of claim 1 wherein the controller means comprises a video multiplexer having a plurality of signal inputs, each coupled to receive a respective one of the video signals, and a signal output coupled to the at least one image digitizer means.

4. The invention of claim 1 wherein the controller means comprises means for adjusting contrast of the digitized video image, and wherein the invention further comprises operator controlled means for controlling the contrast adjusting means.

5. The invention of claim 1 wherein the controller means comprises means for adjusting magnification of the digitized video image, and wherein the invention further comprises operator controlled means for controlling the magnification adjusting means.

6. The invention of claim 1 wherein the controller means comprises means for storing a plurality of digitized video images, and wherein the invention further comprises operator controlled means for selecting one of the stored digitized video images for display.

7. The invention of claim 1 wherein the system further comprises means for storing additional digitized video images associated with subsequent alarm signals during display of the first mentioned digitized video image.

8. The system of claim 1 wherein said at least one video image digitizer means comprises a plurality of video image digitizers, and wherein said controller comprises a video multiplexer comprising a plurality of signal inputs, each coupled to receive a respective one of said video signals, and a plurality of signal outputs, each coupled to a respective one of said video image digitizers.

9. In a video surveillance and intrusion alarm system of the type comprising a plurality of sensor systems operative to generate a plurality of alarm signals, each associated with a respective zone; and a plurality of cameras operative to generate a plurality of video signals, each associated with a respective zone; the improvement comprising:

at least one video image digitizer operative to store on an ongoing basis a plurality of sets of digitized still video images, each set associated with a respective one of the video signals, each stored digitized still video image corresponding to a respective image time;

a controller responsive to the alarm signals to automatically select at least one of the stored digitized still video images for display, said at least one selected digitized still video image corresponding for each of the alarm signals to the zone associated with that alarm signal, and said at least one selected digitized still video image corresponding to an image time prior to the time the respective alarm signal was received by the controller; and

a display coupled to the at least one video image digitizer to display the at least one selected digitized still video image, thereby providing a view of the zone associated with an alarm signal as the zone appeared at a time prior to the time when the alarm signal was received by the controller.

10. The system of claim 9 wherein the at least one video image digitizer and the controller are situated at a central station, wherein the alarm signals are transmitted to the central station with an average propagation delay, and wherein the at least one selected digitized still video image corresponds to an image time that precedes the time the respective alarm signal was received by the controller by an amount selected to compensate for the average propagation delay such that the at least one displayed digitized still video image provides surveillance personnel with a view of the zone associated with the alarm signal as the zone appeared at about the time when the alarm signal was generated.

11. The invention of claim 9 wherein the controller comprises a video multiplexer having a plurality of signal inputs, each coupled to receive a respective one of the video signals, and a signal output coupled to the at least one image digitizer.

12. The invention of claim 9 wherein the controller comprises means for adjusting contrast of the digitized video image, and wherein the invention further comprises operator controlled means for controlling the contrast adjusting means.

13. The invention of claim 9 wherein the controller comprises means for adjusting magnification of the digitized video image, and wherein the invention further comprises operator controlled means for controlling the magnification adjusting means.

14. The invention of claim 9 wherein the controller comprises means for storing a plurality of digitized video images, and wherein the invention further comprises operator controlled means for selecting one of the stored digitized video images for display.

15. The invention of claim 9 wherein the system further comprises means for storing additional digitized video images associated with subsequent alarm signals during display of the first mentioned digitized video image.

16. The system of claim 9 wherein said at least one video image digitizer comprises a plurality of video image digitizers, and wherein said controller comprises a video multiplexer comprising a plurality of signal inputs, each coupled to receive a respective ne of said video signals, and a plurality of signal outputs, each coupled to a respective one of said video image digitizers.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,111,291

DATED : May 5, 1992

INVENTOR(S) : Charles H. Erickson et al.

It is certified that error appears in the above-indentified patent and that said Letters Patent is hereby corrected as shown below:

ON THE TITLE PAGE:

IN THE REFERENCES CITED

On the title page, column 1, under the heading "OTHER PUBLICATIONS", in the first line, please delete "Produce-High" and substitute therefor --Product-High--.

Column 2, line 23, delete "a)arms." and substitute therefor --alarms.--.

Column 4, line 40, delete "ses" and substitute therefor --uses--.

Column 4, line 46, delete "sign3is" and substitute therefor --signals--.

Column 5, line 35, delete "4S" and substitute therefor --48--.

Column 6, line 7, delete "zone" and substitute therefor --one--.

Column 6, line 51, delete "transponder" and substitute therefor --transponders--.

Column 7, line 43, delete "n contrast" and substitute therefor --a contrast--.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,111,291

DATED : May 5, 1992

INVENTOR(S) : Charles H. Erickson et al.

It is certified that error appears in the above-indentified patent and that said Letters Patent is hereby corrected as shown below:

Column 7, line 56, delete "c)ear" and substitute therefor --clear--.

Column 10, line 5, delete "buffets" and substitute therefor --buffers--.

Column 10, line 21, after "42", insert —.—.

Column 10, line 23, delete "non-liner" and substitute therefor --non-linear--.

Column 10, line 24, delete "g zone" and substitute therefor --9 zone--.

Column 10, line 35, delete "4S" and substitute therefor --48--.

Column 11, line 38, delete "component," and substitute therefor --components,--.

Column 12, line 18, delete "13B" and substitute therefor --138--.

Column 12, line 20, delete "computer 26" and substitute therefor --computer 26'--.

Column 12, line 44, delete "it is" and substitute therefo --i is--.

Column 13, line 61, delete "was" and substitute therefor --has--.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,111,291

DATED : May 5, 1992

INVENTOR(S) : Charles H. Erickson et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 14, line 64, delete "imges" and substitute therefor --images--.

Column 15, line 24, delete "when" and substitute therefor --When--.

Column 15, line 26, delete "14" and substitute therefor --134--.

Column 15, line 32, delete "hand" and substitute therefor --and--.

Column 16:

Claim 1, line 13, delete "thee" and substitute therefor --the--.

Column 17:

Claim 2, line 13, delete "at the zone appeared at about he" and substitute therefor --as the zone appeared at about the--.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,111,291

DATED : May 5, 1992

INVENTOR(S) : Charles H. Erickson et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 18, Claim 16, line 5, delete "ne" and substitute therefor --one--.

Signed and Sealed this

Twenty-ninth Day of March, 1994

Attest:

BRUCE LEHMAN

Attesting Officer

Commissioner of Patents and Trademarks

US005111291B1

REEXAMINATION CERTIFICATE (3881st)

United States Patent [19]

[11] B1 5,111,291

Erickson et al.

[45] Certificate Issued Sep. 28, 1999

[54] **AUTO FREEZE FRAME DISPLAY FOR INTRUSION MONITORING SYSTEM**

[75] Inventors: **Charles H. Erickson**, Woodridge; **Peter A. Erlo**, Morris; **James E. Kase**, Tinley Park, all of Ill.

[73] Assignee: **Commonwealth Edison Company**, Chicago, Ill.

Reexamination Request:
No. 90/004,924, Feb. 23, 1998

Reexamination Certificate for:

Patent No.:	**5,111,291**
Issued:	**May 5, 1992**
Appl. No.:	**08/765,213**
Filed:	**Sep. 25, 1991**

Certificate of Correction issued Mar. 29, 1994.

Related U.S. Application Data

[62] Division of application No. 08/548,847, Jul. 6, 1990.

[51] **Int. Cl.**^{6} **H04N 7/18**

[52] **U.S. Cl.** **348/153**; 348/152

[58] **Field of Search** 348/152, 153, 348/154, 159, 155, 705, 22, 24, 82

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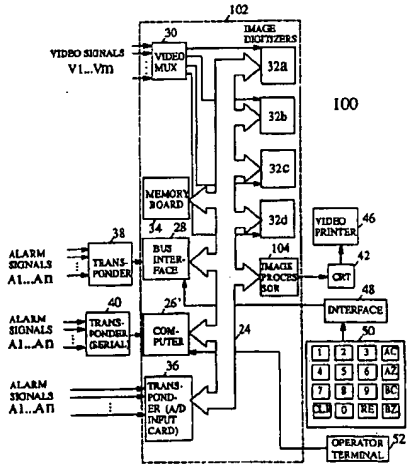
Primary Examiner—Victor R. Kostak

[57] **ABSTRACT**

A Video monitoring system responds to an intrusion alarm by automatically presenting still video images of the zone of the alarm at or about the time of the alarm. The operator can control magnification and contrast to enhance the displayed image. In one system the displayed images are images taken at times both before and after the alarm was received by the monitoring system.



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REEXAMINATION CERTIFICATE ISSUED UNDER 35 U.S.C. 307

THE PATENT IS HEREBY AMENDED AS INDICATED BELOW.

Matter enclosed in heavy brackets [ ] appeared in the patent, but has been deleted and is no longer a part of the patent; matter printed in italics indicates additions made to the patent.

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT:

The patentability of claims **1–16** is confirmed.

* * * * *